POWER

Volume 65 New York, June 14, 1927 *Number* 24

The Potency of Speed

IN 1785 Boulton & Watt built for the Albion Flour Mills, the first establishment that was founded to run entirely by steam power, a 50-horsepower engine.

It had two 18-foot flywheels, a great oak walking beam, 25 feet long and 29 inches deep, and a connecting rod, also of oak, 12x13 inches in section and 22 feet long The cylinder was 34 inches in diameter, the stroke 8 feet, and it made 16 revolutions per minute.

And all this for 50 horsepower!

What would these old engineers have thought of the 50-horsepower high-speed, self-contained steam engine of today?

How would they have regarded a prediction of 100,000 horsepower out of a little humming housing that could be set in that same room?

How would engines weighing less than two pounds to the horsepower have sounded to them?

It has been done by speeding up!

In the piston engine the power is a function of the displacement per unit of time. And its power has been multiplied not only by increasing the piston speed, but by increasing the other factor of power, the pressure, by speeding up the molecules of the steam.

And then, instead of urging a comparatively slow-moving piston along by the impact of these swiftly shooting molecules against it, we gathered the energy of this molecular motion into jets and made them impact upon turbine blades moving at 1,000 feet per second instead of upon pistons moving at 1,000 feet per minute.

And now we are getting some comprehension of the energy that is involved in the little planetary systems that make up the molecules and atoms, and are beginning to wonder how we can divert more of it to useful purposes.

Sir Oliver Lodge says that the energy of one-tenth of a milligram, the smallest visible or weighable speck, moving with the speed of light equals that of a load of 600 tons falling a mile.

And that "if ever the human race get hold of a means of tapping even a small fraction of the energy contained in the atoms of their own planet the consequences will be beneficent or destructive according to the state of civilization at that time attained."

F. R. Low

Lifting Heavy Power-Plant Equipment*

By N. L. REA
Contract Service Department, General Electric Company

ATTENTION is called to a number of methods that have been used to lift heavy pieces of power-plant equipment that have proved satisfactory as to safety and building cost.

REAMS have been written on the use and misuse of eyebolts, yet every once in a while someone tries to use them in a way that is hazardous. For this reason cast-steel trunnions have been adopted for handling large vertical generator fields and they have proved to be much more satisfactory than eyebolts. Fig. 1 shows a typical arrangement. The trunnion was placed on the shaft when it was on the skids, and a pair of slings used around the trunnion and to the crane hook to turn the shaft up on end and to lift it. The two slings will slide around the ends of the trunnion as the shaft comes to an upright position. The flange on the shaft was set on the assembly pit floor.

There was a ring of bolts set in the concrete to match the coupling bolt holes. The holes in the flanges were dropped over these bolts and the nuts tightened, holding the shaft securely while the rotor sections were assembled. The picture shows the complete field structure being lifted for placing in the stator. The slings used were of 1½-in. steel cable and were used only for handling the completed rotors. Three wraps of cable were used on each end of the trunnion, giving twelve strands to carry the total load. They more or less fit themselves to the hook and trunnion and, if not straightened out between lifts, will be bent very little for subsequent lifts.

Headroom is sometimes at a premium, and several methods have been worked out to reduce the height that the crane must be above the generator floor to place the field structure in the stator. This one lift usually determines the height of the crane and this in turn the height of the building.

Several small power houses have been equipped with hand-operated cranes that have two hoists. With this arrangement the hitch can be made around the spokes near the rim, using both hoists, and the upper end of the shaft allowed to pass up between the two hoists and the crane rack at the top of the lift. The hoists are used together in handling the armature and are handy in turning over pieces of equipment during unloading and erection. This plan allows a considerable saving in building costs, and the increased cost of the cranes

*See previous articles, page 238, Feb. 15 and page 667, May 3, 1927.

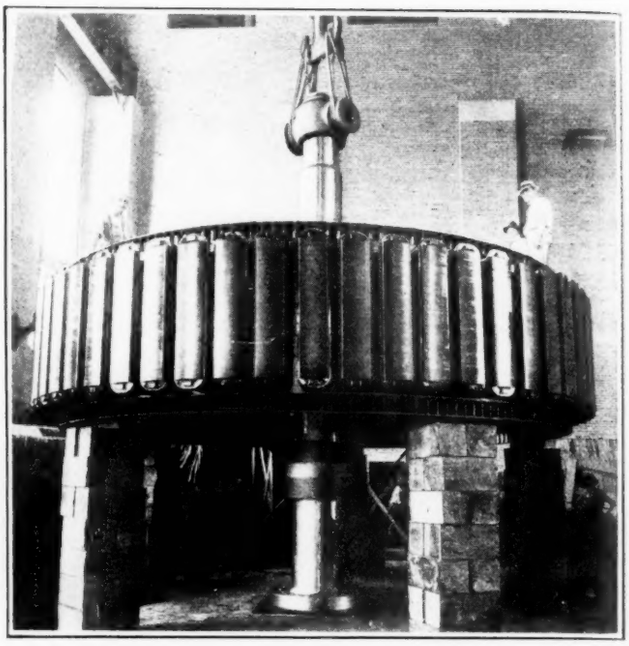


Fig. 1—Trunnion used to lift rotor

is comparatively small. Such an arrangement can be used to good advantage on the smaller power houses with a small number of units.

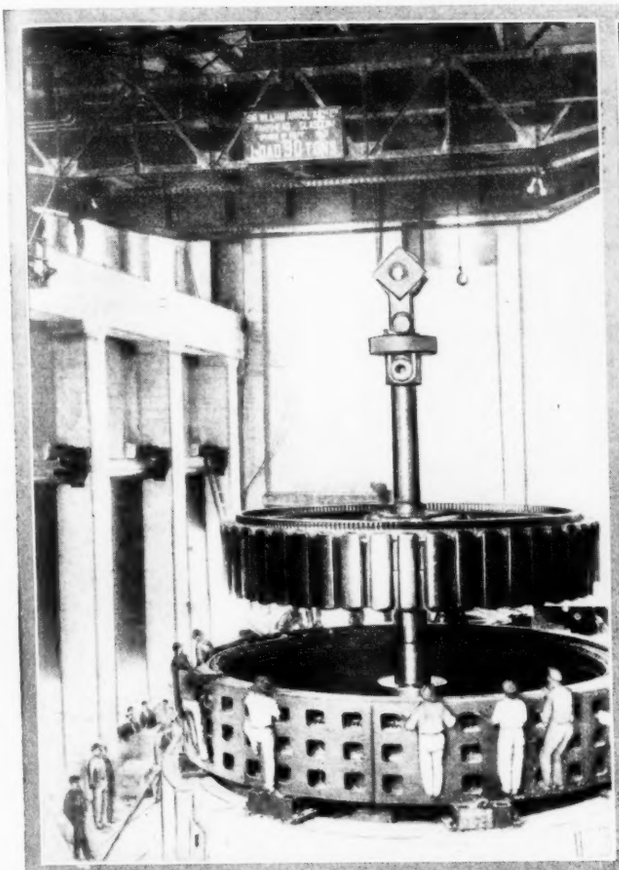
Fig. 2 shows another way of shortening the hitch. The lugs on top of the lifting plate on the shaft, were designed to replace the crane hook. The rest of the details are self-evident from the picture.

The larger power houses are usually equipped with two cranes to speed up the erection work. In many cases a material saving in the headroom and crane capacity may be made by using a lifting device so that both cranes can be used for handling the revolving field. Fig. 3 shows an arrangement of this sort, with a lifting beam between the hoists of the two cranes.

The Niagara Falls Power Co. carried this plan still farther in handling the 65,000-kva. generators. They had two cranes each equipped with two 100-ton hoists. The sheave blocks of these hoists have hollow axles. These blocks could be lowered between the arms of the lifting device and pieces of shafting pushed through holes in the double end of the arms and the hollow spindles. Fig. 4 shows this lifting device as it was attached to one of the generator field structures.

The lifting block is fastened to the shaft with a circular key and is trunnioned on the main girder of the lifting device. The ends of this girder are also trunnioned to the girders attached to the crane hooks. With this arrangement one hoist could be moved at a time and the power requirements and rate of hoisting cut down materially. As the total weight was over four hundred tons, this was an important consideration. A special circular keyway was cut in the shaft somewhat lower than the regular keyway for the thrust bearing, to make the hitch as low as possible. This combination worked well and must have made a considerable saving in building and erection costs.

While on this subject, a method worked out by another power company may be of interest. They were faced



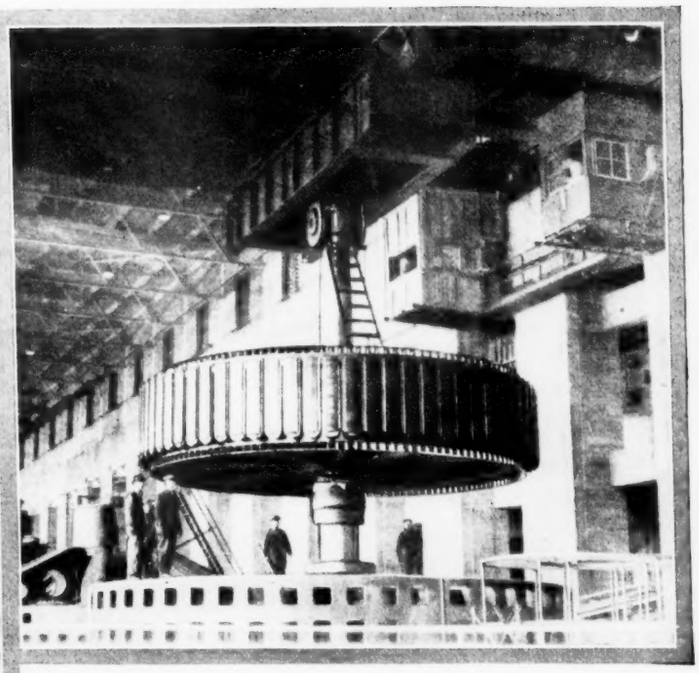
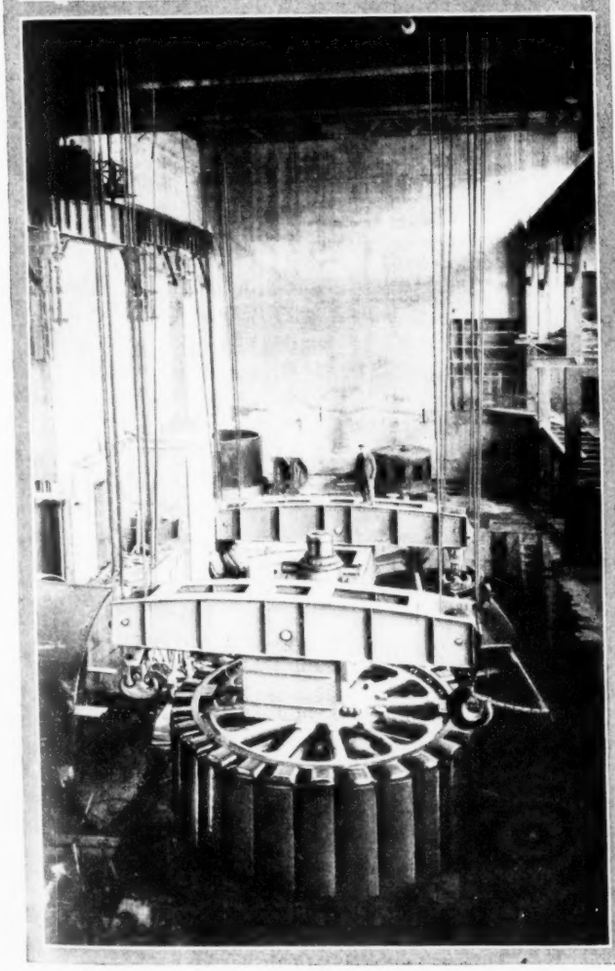


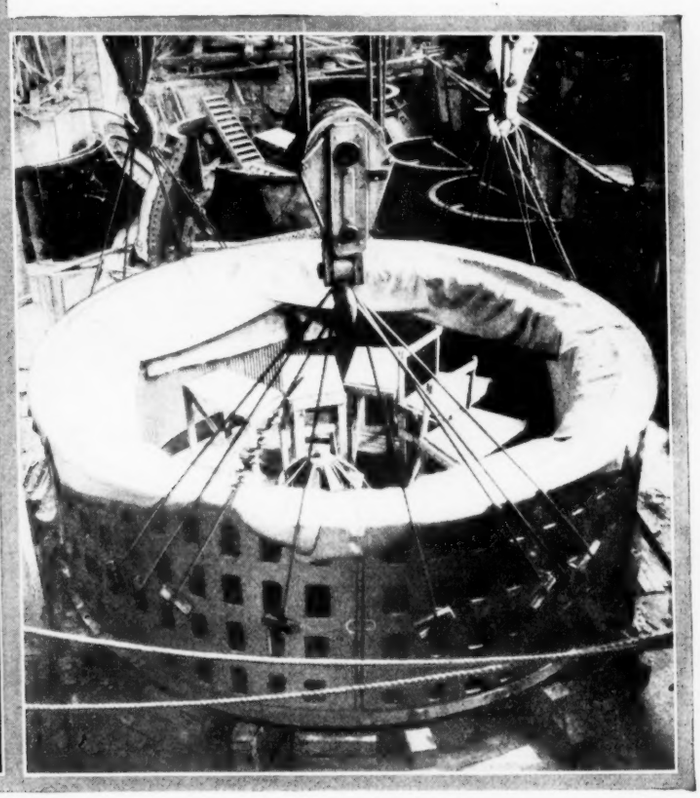
Fig. 2 (Left)—Lugs on top of the lifting plate designed to replace the crane hook to shorten the hitch

Fig. 3 (Above)—Rotor lifted by two cranes, connected through lifting beam

Fig. 4 (Lower left)—Four hoists on two cranes used to lift rotor through an arrangement of lifting beams

Fig. 5 (Below)—Two hoists on one crane and one on another used to lift stator





with the problem of installing a larger generator in their power house. The height of the crane lift required to swing the coupling of the new generator over the rim of the armature frame was several feet more than the maximum height of the crane hook. The station

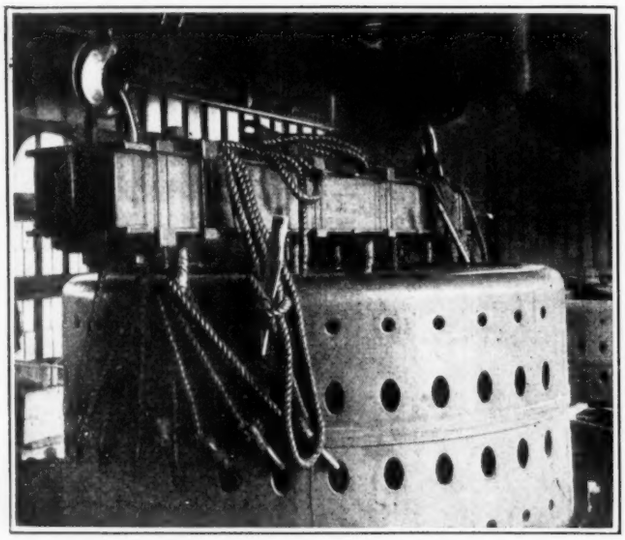


Fig. 6—Hemp rope connected by hooks to stator for lifting

had a single crane, and this was equipped with one hoist. The armature was shipped in quarters and three sections were assembled on the foundation, with the joint coils in place. The field was brought inside the

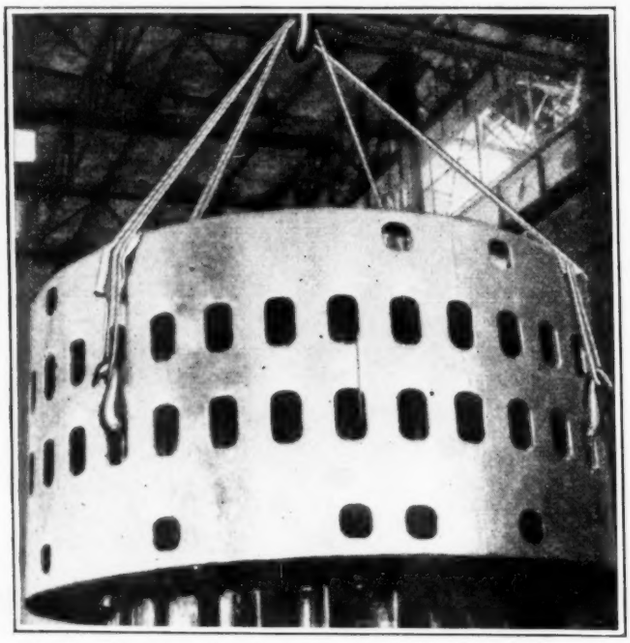


Fig. 7—Wire rope connected by hooks to stator for lifting

armature through the opening and carried across until the shaft was close to the punchings. The coupling cleared the foundation by a few inches when the crane hook was at the top of its lift.

Previously to placing the field, two heavy steel horses were erected outside and close to the armature frame. These horses were high enough so that steel beams could be slid across them over the armature rim to support the field. The last quarter of the stator was then swung into place and the joint coils put in. After serving their purpose, the horses and beams were stored as part of the tool equipment so that they were available for future work.

Considerable thought and experimenting have been used in handling armatures. One might say we had gone through a complete cycle. The first machines were handled with hemp rope threaded through holes in the armature frame. Then the fear and danger of cutting led to using hooks in the holes of the frame. Fig. 6 shows this method as used over twenty years ago. When wire rope came into use the idea of hooks persisted and the method shown in Fig. 7 was used. Of late years the practice of threading wire cable through the holes in

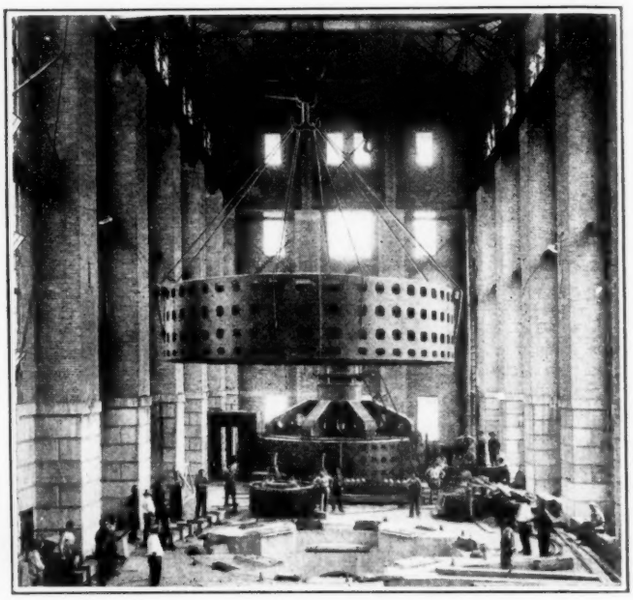


Fig. 8—Stator lifted by a double hook on one crane

the frame and protecting it from cutting by proper stoppering has come into use. There is nothing better for stoppering than pieces of leather belting, and the nearest junk man may have just what you want.

Fig. 5 shows a hitch using two hooks on one crane and one hook on the other crane. In Fig. 8 the hitch is made on a double hook. Both of these views show a handy kink that can be applied to good advantage. Blocks of wood are wedged under the cables to make the final adjustments and divide the load among the various ropes.

About the only place forged hooks are used at present is where the crane has a closed eye instead of the ordinary single or double hook. In these cases slings with an eye in each end are used and a forged "S" hook is employed to join the two ends together. These hooks are designed to have the same strength as the cable. The slings may be passed through the crane eye and through the holes in the armature frame several times, and then the two eyes joined together with the "S" hook.

After the last rule is written and the last safety-first committee meeting is over, we must depend on the judgment and common sense of the riggers. So it behooves us to see that these men are picked for their common sense and level heads and then give them intelligent training and supervision.

Should you take

A Temporary Engineering Job?

Part I—The Dark Side

By H. M. FRIEND

YOUR answer to this temporary-job question may shape your entire life. On first thought you will probably say, "No temporary engineering jobs for me; I'd just be working myself out of a place in a short time, and then I'd have to start all over again getting a real one." But there are other things to consider besides duration. With such jobs often come experience and responsibility and association with seasoned engineers who have been on interesting work all over the world. You will find disadvantages. as well as advantages. In this article the darker side is discussed. A subsequent issue will show a brighter picture.

ELECTRICAL ENGINEER, with five years' experience for the erection of sub-station and generating equipment. Six months work. Salary $300 a month. Location, California.

IF THIS were in your line of work, would you consider taking it? There are many things to say both for and against taking a temporary engineering job. Let us first consider some of the disadvantages.

The most obvious point is its temporary nature. After the work has been completed, you will have to find another job. It would seem that you are thus tying yourself up from getting a permanent place and that you are merely putting off the evil day when you will again have to look around.

Then the uncertainty of completion of the work is a most undesirable feature. Temporary engineering jobs almost always run longer than schedule. It is impossible to estimate closely the time for most construction, appraisal and many other jobs, and an optimistic figure for their completion is usually set. Unforeseen things are constantly developing during the work. This uncertainty often means real money out of your pocket. A six-weeks job that runs for four months usually means the payment of rent on a house or an apartment which should have been vacated or sublet.

I know of one case where a six-months job in Canada spread out to seven years. The furniture of the engineer's family was not shipped to them because each year they expected to return the following spring. Fourteen hundred dollars was the total storage cost for the furniture!

Another temporary job for February had continued through the summer. In the lobby of a country hotel one warm Sunday in August sat a crowd of engineers wishing for a ride. And each one of them had a perfectly good car back home!

The mental attitude fostered by the temporary job is not the happiest. The uncertainty of the future overhangs you, and it cannot always be forgotten. It is harder to give your utmost enthusiasm to the work under these circumstances.

On a temporary job you usually work under much higher pressure than on a permanent one, as there is often a great rush for completion. Therefore you have little time to put out lines for a permanent job. This means that you have to wait till the job is over before you can begin an aggressive campaign to locate yourself.

You may be working for a permanent engineering organization which is taking on a few extra men for this particular job. Here you are at a disadvantage compared with the regular men. They have been on this kind of work right along, while you have to learn the new system and the new work, hence you do not show up as well as they do. You will probably be put under one of them and often not given the best work, as you are considered only a temporary man.

There may be important personal considerations. Family ties are often affected. Separations may have to

Another young couple had brought along two large Angora cats

be considered. If you are married, you will probably feel that it impossible for you to take a temporary job, but this should not be so. Where the work is to continue for any length of time and where distances prevent return home, you had better plan taking your family with you if it is at all possible. There are few jobs, even in construction camps, where this cannot be arranged.

Most companies will tell you that they are hiring you and not your family and that you will have to stand their expense. The better pay of the temporary job will make up the difference. Many employers will tell you that they prefer to have the families with the men because they know the men will be more contented.

Without your family you will be counting the days till your return and will feel a stranger in a strange land. But when they are with you, the construction camp will soon be like home. As for the women folk and children, it is all a wonderful thrill for them. They stir up social affairs for themselves and are often sorry

when the time comes to say "good bye" to the new friends and go back to the big city.

At my first construction camp I inquired of a young engineer how his wife stood the different life and the lack of many of the luxuries of home. He replied that she had never had as social a time in her life, that she was in all sorts of clubs and had become an expert card player. Another young couple had driven down and had brought their pets along, consisting of two large angora cats, one pure white and the other all black. Then they felt very much at home.

In most construction camps the single men live in dormitories and eat at the mess hall, while the families are given small temporary houses and prepare their own meals. It is a familiar statement that the married men are by far the better fed and housed. Therefore a family may be the opposite of a handicap in considering a temporary job.

A discussion of temporary jobs should mention one important point frequently misunderstood. That is the question of overtime. There is often a great amount of overtime. The job is usually being rushed to completion. As the engineer is paid by the week or month, he is usually paid nothing for overtime, while the mechanics, electricians and laborers get from straight time to double time. This often results in the engineer making less than they do. Then, on temporary jobs where he will be dropped as soon as the work is finished, he is being asked to work himself out of a job. For the permanent men in the organization it is a different matter because they are being carried through slack times. It would seem that the fair course would be to pay the engineer for his overtime.

Much overtime is unnecessary, and when it is paid for it is surprising to see how it disappears. On a certain temporary job that I know of, the young engineers were called upon every Sunday to make special tests. They were paid nothing extra for this work, while the electricians were pulling time and one-half. After a while, however, the overtime suddenly ceased. Orders had come from headquarters to discontinue it, as the cost of the job was being increased from the overtime pay received by the electricians.

In accepting a temporary job, even more so than a permanent one, you should have your agreement in writing, the salary, status of your expense account, working hours, overtime pay if any, and the matter of a vacation if the work continues for some time. You should ask for a letter confirming your appointment and including these points. After you have started work, and often at a distance from home, it is quite an advantage to have everything clearly understood—and in writing.

To be concluded

THE VALVE OF A SLIDE-VALVE ENGINE may be set for equal lead on both ends or equal cutoffs, but the angularity of the connecting rod prevents obtaining both equal leads and equal cutoffs. It is usually more desirable to have equal leads than equal cutoffs. If the engine is large and cannot be turned easily, a good method of setting the valve is to loosen the eccentric and shift it until the maximum port opening is obtained on the head end. Next shift the eccentric so the crank end has its maximum port opening. Alter the valve rod to make the openings the same. Next shift the eccentric to give the desired load.

What Do You Know?

A LOT of us are going through life under a delusion that engineering is an open book. The trouble is that there is no one to check us up. We are somewhat in the position of a party by the name of Sidney Bluch, who acquired fame as possessing a remarkable memory from his habit of quoting statistics on the world's output of suspenders, sheet music and the like. He got by simply because no one else in the crowd knew what the suspender crop had been. Still, Sidney undoubtedly nursed a secret feeling that he was bluffing. The ten questions below may be used to discover if you, too, are bluffing. Answer them and then turn to page 918 to see what the editor believes are the correct answers. Do not hesitate to call him if he is wrong.

Ques. 1—Does the crank of a steam engine pull the rod and piston across dead center?

Ques. 2—Why should not a turbine be run at low load?

Ques. 3—If a 60-cycle alternating-current generator runs at 3,600 r.p.m., how many poles has it?

Ques. 4—What is a "soft patch"?

Ques. 5—Is there a marked difference in the temperatures of the water in the bottom and that in the top tubes of a water-tube boiler?

Ques. 6—Approximately how many pounds of air is needed per pound of coal theoretically to permit perfect combustion?

Ques. 7—If the condenser and ammonia receiver are on the ground floor, will the head pressure of 150-lb. gage be increased if the brine cooler is placed on the roof 100 ft. above the receiver, with the expansion cock at the cooler?

Ques. 8—How much lap have the steam valves of a duplex pump?

Ques. 9—If a two-stage air compressor discharges against a receiver pressure of 100-lb. gage, what is the best intermediate pressure?

Ques. 10—If you were in charge of a 500-hp. gas engine and without previous trouble the engine started to backfire, give two reasons for the backfiring.

Another Firm Builds Large Diesel

Double Acting M. A. N. Diesel Built by Hooven-Owens-Rentschler—Novel Scavenging Design—Engine Ran Through Acceptance Test Without Difficulty

THE completion and test of a 3,350-hp. engine for the Shipping Board mark the entrance of the Hooven, Owens, Rentschler Co., into the building of Diesels. This engine, which is to be installed in the "Seminole," is of the double-acting two-stroke cycle type, port-scavenging being used. The cylinders are 27.5 in. in diameter by 47.25-in. stroke, the rating being 825 hp. per cylinder.

The base of the engine is made up of a bedplate with wide and deep sections. Directly on top of the bedplate are the housings, which are bolted to the top of the lower entablature, this being a heavy cast-iron section extending the entire length of the engine. To the upper faces of this casting are set the cylinder columns which again tie into the upper entablature. The upper cast-iron section is of similar construction to the lower, of a deep section and goes the entire length of the engine. In addition, there are four tie bolts for each cylinder which extend from the bottom of the bedplate to the upper part of the upper casting.

The cylinders and cylinder jackets are set in between the columns, and inside of the cylinder jackets are the liners made in halves, one for the upper and one for the lower working cylinder. These are so arranged that there is an opening in the center, giving freedom of expansion. To the lower entablature is bolted the cylinder jacket and to the upper member is bolted the upper cylinder liner. The cylinder jacket is held to the upper liner by a stuffing box giving it freedom of expansion and contraction. The idea of the entire construction is to make a solid structural design in which all the tensile stress is absorbed by the tie rods.

The engine operates on the M.A.N. system of scavenging. Each liner has two sets of ports on the same side, one directly above the other. The lower ports are the scavenging ports, and the air is blown in across the top

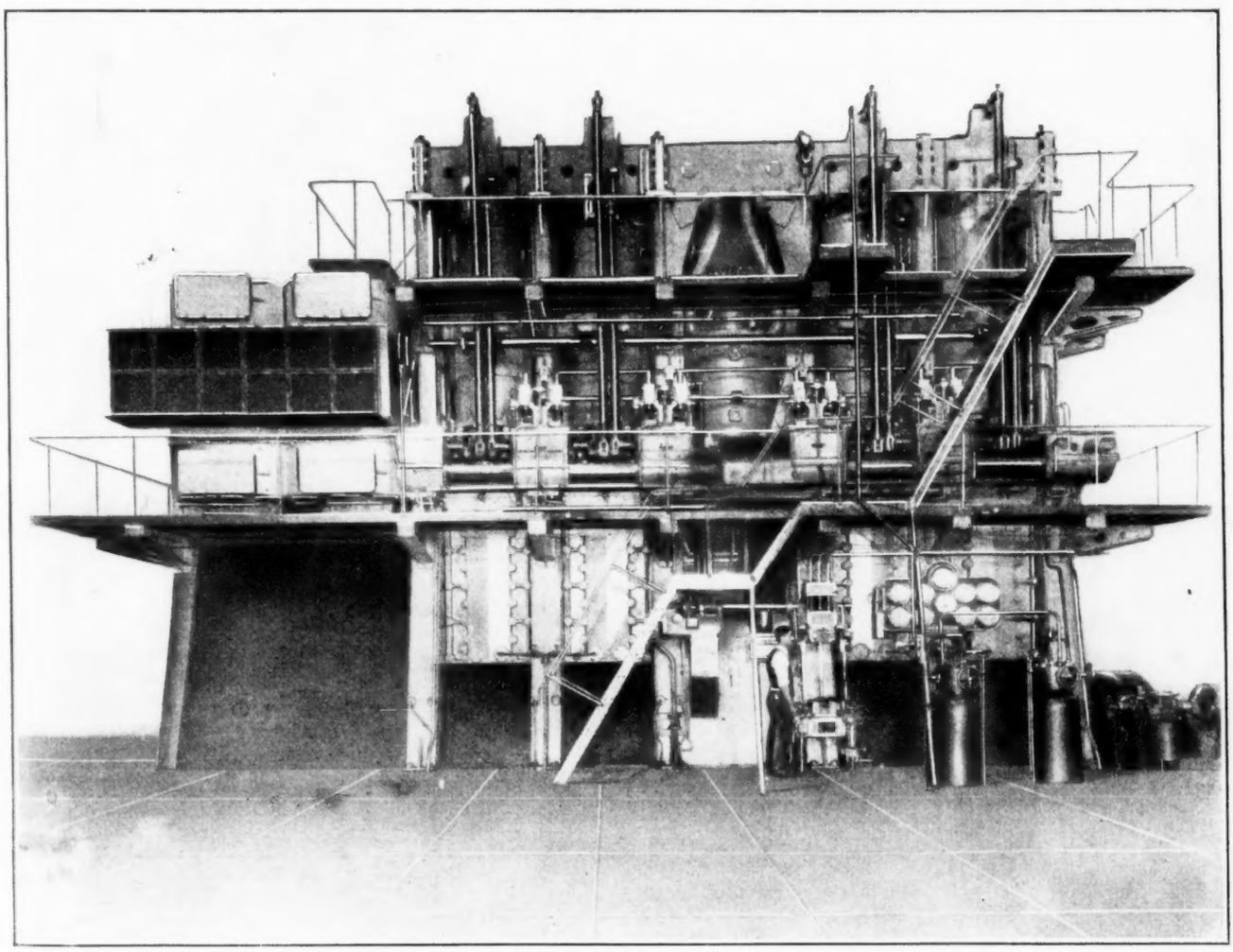


Fig. 1—View of the 3,330-hp. double-acting two-stroke-cycle Diesel on test floor

of the piston, forced to the top of the cylinder and then exhausted through the exhaust ports directly above the scavenging ports. This system has been thoroughly tested and has proved efficient not only in the preliminary investigation, but in engines in actual operation.

The scavenging pumps are of the double-acting type with plate valves designed for low air pressure. The pump pistons are driven through crossheads direct from the crankshaft.

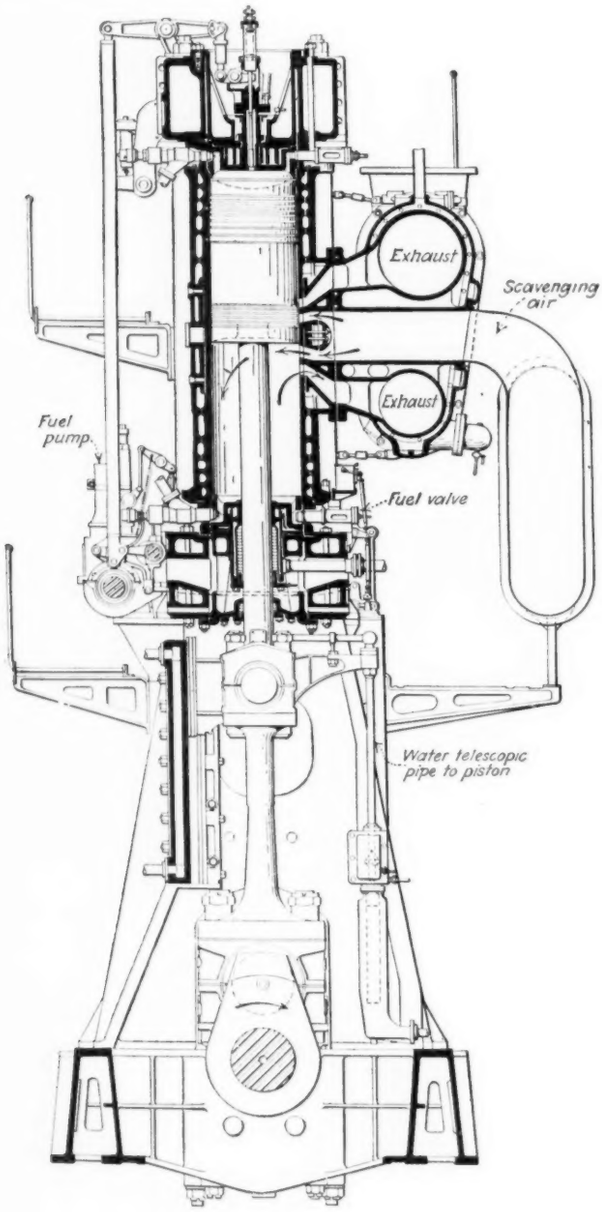


Fig. 2—Section of engine through a working cylinder

The air is cooled between the stages through coolers which are provided with water separators so as to draw off the moisture from the air between stages.

The fuel and starting valves for both the upper and lower cylinders, are driven from the camshaft located in the middle of the engine. The camshaft receives the motion from the mainshaft through a set of spur and bevel gears.

The fuel pumps are mounted on brackets directly

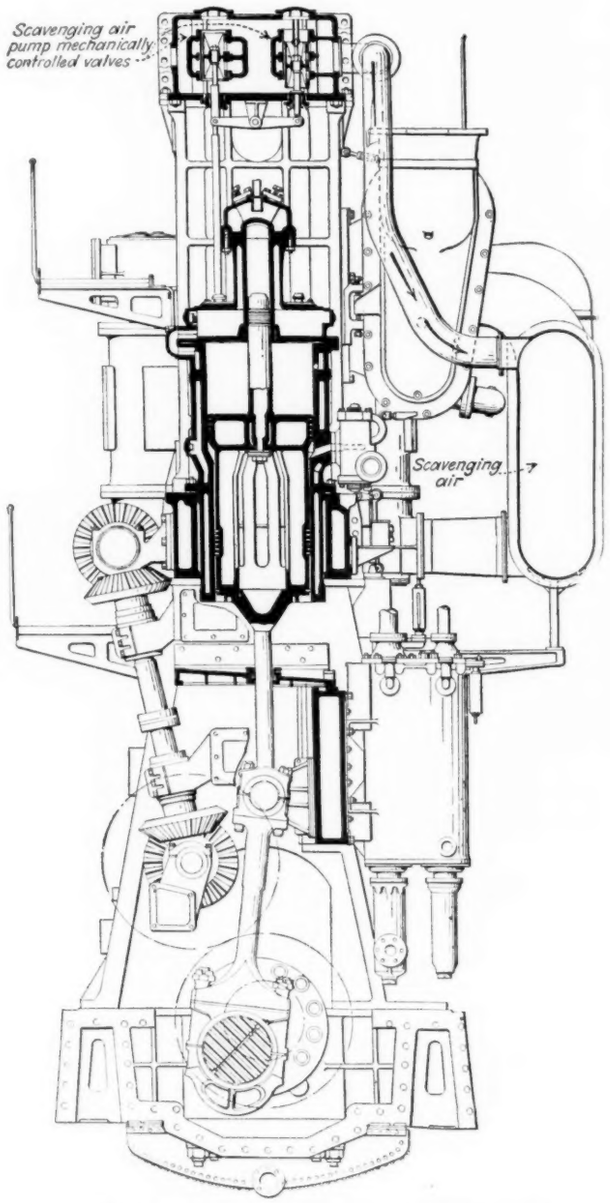


Fig. 3—Cross-section of air compressor, showing camshaft drive

The engine uses air for fuel injection and has one fuel valve in the upper cylinder head and four in the lower cylinder head. In addition, there are starting valves in the top and the bottom, as well as relief valves.

The air compressor is of the conventional three-stage type driven from the crankshaft through a connecting rod and crosshead. The pistons are of the step design with the high-pressure cylinder on top, the low-pressure in the middle and the intermediate at the lower end.

above the camshaft and are driven from cams on the camshaft. This feature is novel and gives a timing to the fuel pumps which makes possible a close regulation of the engine. There is one fuel plunger for each upper and lower cylinder.

The engine is provided with an overspeed governor of the Aspinall type, and the regulation of the engine is accomplished by bypassing the discharge valves of the fuel pumps.

The materials used in the engine are cast iron for the structural parts, special cast iron for the liners resisting wear, cast steel for the cylinder heads and in small parts. The piston heads are also of cast steel and constructed with proper openings for water circulation.

The engine, including scavenging pump and compressor, weighs approximately 850,000 lb. Its length is 40 ft., the width 15 ft., and the height 28 ft. above the center of the shaft.

The engine has been subjected to a 30-day acceptance non-stop test by the Shipping Board, but the test data are not available. The engine ran continuously during this last test save for a short shutdown due to a leaky water connection. A centrifuge was used to purify the lubricating oil, and the first knowledge that there was any trouble was gained through observation of an increase in the water discharged from the centrifuge. Although the water was leaking into it at the rate of 500 gal. per hour, the engine continued to function.

Load Control on Electric Steam Boilers

By C. R. Reid*

THE resistance of water varies considerably, depending upon the amount of impurities it contains. For distilled water at 18 deg. C. one authority gives the resistance as 200,000 ohms per cubic inch. The resistivity of different samples of ordinary raw water will vary all the way down from a value somewhat below this to one or two thousand ohms per cubic inch. The temperature of the water has a marked effect on its resistivity as shown by the curves in Fig. 1. These curves show that the resistance decreases quite rapidly with increase in temperature, up to about 30 deg. C., then decreases more slowly as the temperature is raised to higher values. By plotting the temperature against the resistance on a logarithmic scale, as shown in Fig. 2, it is found that the points fall in a straight line.

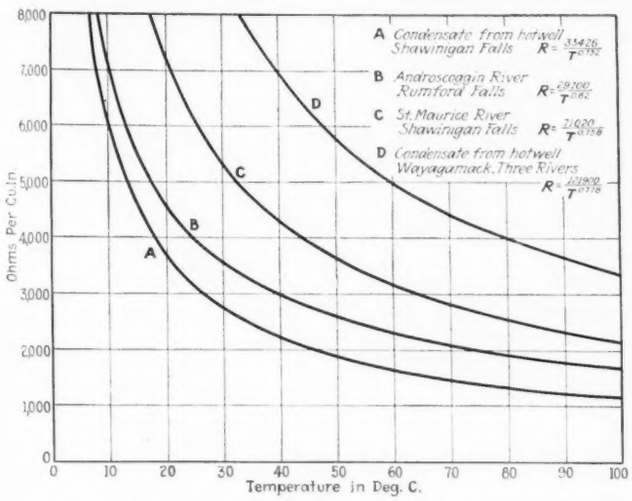

A Condensate from hotwell Shawinigan Falls $R=\frac{33426}{T^{0.692}}$
B Androscoggin River Rumford Falls $R=\frac{29700}{T^{0.662}}$
C St. Maurice River Shawinigan Falls $R=\frac{21600}{T^{0.758}}$
D Condensate from hotwell Wayagamack, Three Rivers $R=\frac{102800}{T^{0.778}}$
Ohms Per Cu.In.
Temperature in Deg. C.

Fig. 1—Resistance-temperature curves for water plotted on an equal-parts scale

The general equation takes the form $R = \frac{A}{T^B}$, in which R is the resistivity of the water in ohms per cubic inch, T the temperature in degrees centigrade, and A is a constant ranging in value from 30,000 to over 120,000 for the samples tested. The exponent B of T is likewise a constant for a given sample. In the samples tested it varied from 0.62 to 0.778. This constant B is the measure of the slope of the straight lines in Fig. 2. An inspection of Fig. 2 will show that the lines are approximately parallel; there is no great variation to be expected in the value of B.

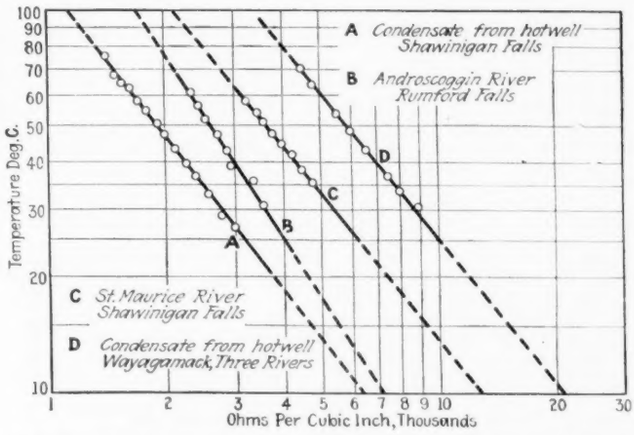

A Condensate from hotwell Shawinigan Falls
B Androscoggin River Rumford Falls
C St. Maurice River Shawinigan Falls
D Condensate from hotwell Wayagamack, Three Rivers
Temperature Deg. C.
Ohms Per Cubic Inch, Thousands

Fig. 2—Resistance-temperature curves for water plotted on a logarithmic scale

Water as a resistor has come into extensive use in the last ten years in connection with the generation of steam from electric energy. At the present time there is installed in the Province of Quebec electric steam generators or boilers with a total rated capacity of 275,000 kw. and a daily steam production running up at times to 15,000,000 pounds.

The variation in resistivity of the water may be taken advantage of when a boiler is being put into service. If the water is cold the generator will pick up a comparatively small load when connected to the line, and as the temperature of the water rises, the load will pick up as the resistivity falls in accordance with a curve similar to those shown in Fig. 1. Input is controlled at all times by varying the water level in the generator; that is, varying the immersion of the electrodes.

Control is also obtained by varying the purity of the water. As the water is evaporated, the salts that are in solution in the feed water, remain in the boiler with a resultant decrease in the resistivity of the water. Thus, as the boiler continues to operate, load is picked up gradually, owing to the accumulation of impurities. If it is desired to maintain the load steady, bleeder valves are opened which drain off a small amount of water from the bottom of the drums. To reduce the load the bleeder valves are opened wider. On a closed system where all the condensate is returned to the boiler, the percentage of impurities in the water is constant and regulation of input is accomplished by adjustment of the water level. In the usual installation where makeup water is constantly being supplied, control is best accomplished by a suitable combination of water level and bleeder adjustment.

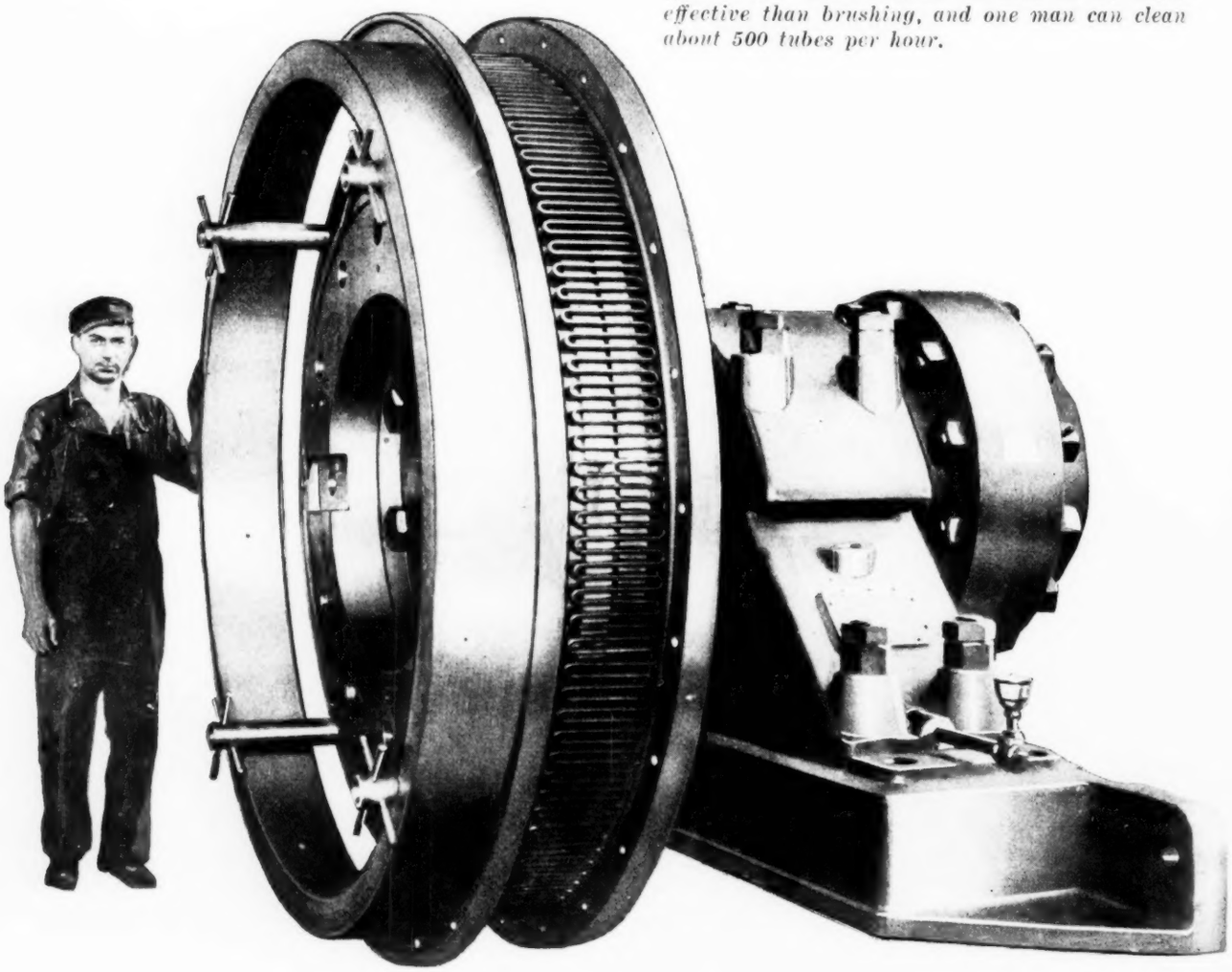
An electric boiler started cold with clean water at minimum level will have an initial input about 10 per cent of normal rating. Continuous operation at 25 per cent rating is about as low as is practicable, because the amount of bleeder water becomes excessive.

*Power-House Superintendent, Shawinigan Falls Water & Power Co., Shawinigan Falls, Quebec.

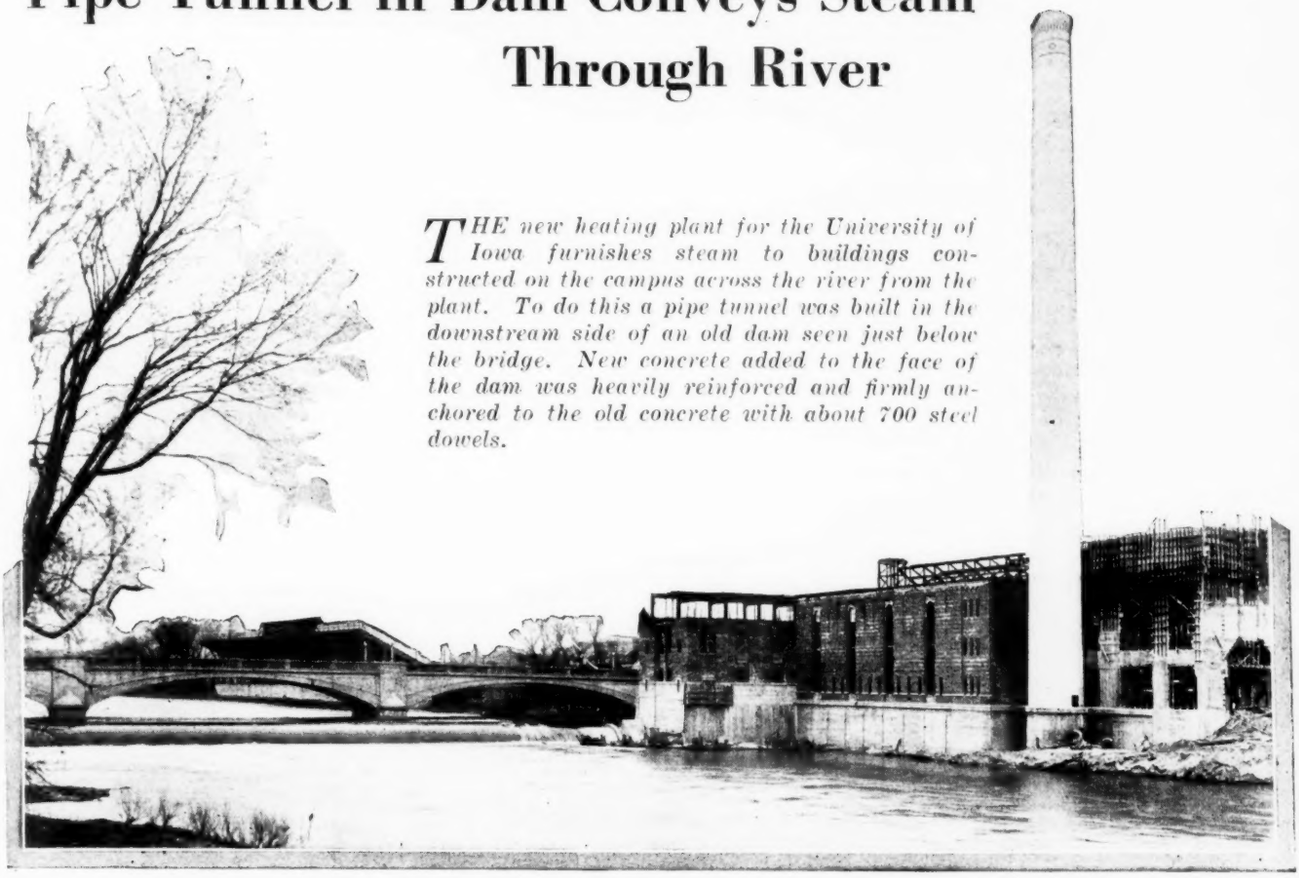
Large Flexible Coupling Protects Motor from Shock

THE Central Alloy Steel Corporation has in service on a 34-in. reversing blooming mill a Falk flexible coupling which is the largest in the world. It has a rated capacity of 21,000 hp. at 100 r.p.m. and is actually transmitting a torque of 760,000 ft.-lb. at 60 r.p.m. (8,700 hp.). The mill, direct connected through the coupling to a special motor, reverses six times a minute. It is claimed that in two years of operation not a minute's loss of production has been experienced from breakdown, although the coupling has absorbed tremendous overloads. This coupling is said to have effected a considerable saving in the maintenance of mill, motor and coupling.

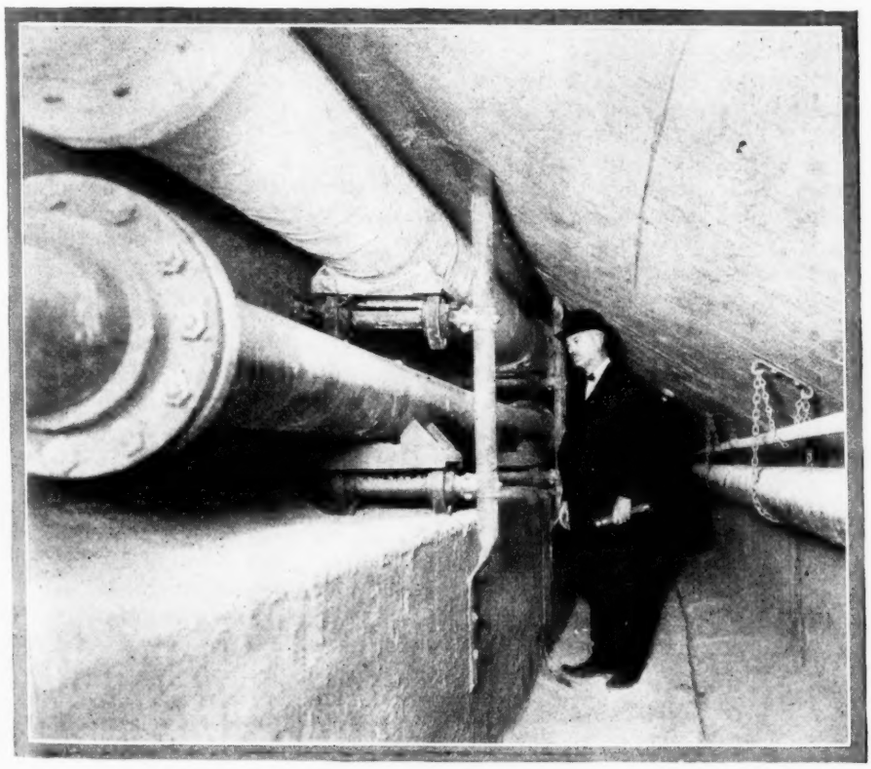
THIS hydraulic pistol was developed by the Brown Boveri engineers for forcing rubber balls through condenser tubes for removing sludge. A ball slightly larger than the tube is placed in the end of the tube, and the pistol is pressed against it. This opens a valve admitting water under pressure behind the ball. After passing through the tubes, the ball falls into a channel and automatically returns to the operator (patented). This method is said to be more effective than brushing, and one man can clean about 500 tubes per hour.



Pipe Tunnel in Dam Conveys Steam Through River



THE new heating plant for the University of Iowa furnishes steam to buildings constructed on the campus across the river from the plant. To do this a pipe tunnel was built in the downstream side of an old dam seen just below the bridge. New concrete added to the face of the dam was heavily reinforced and firmly anchored to the old concrete with about 700 steel dowels.



THE tunnel through the dam, large enough for a man to walk in comfortably, contains two 8-in. steam lines and a 6-in. condensate return line. A water main 12 in. in diameter will be added later. The forged steel, lap-welded steam pipes are supported on special roller hangers and are insulated with 3 in. of magnesia molded covering. Steam at 125 lb. pressure is used for heating.

Spring Mounting Reduces Vibration in Single-Phase Machinery

By G. W. PENNEY
Power Engineering Department, Westinghouse Electric & Manufacturing Company

IN SINGLE-PHASE motors and generators the torque is produced by a single alternating current. Since the instantaneous power is the product of the instantaneous current and voltage, this power or torque is of a pulsating nature. The pulsations, which are of twice the line frequency, are superimposed on the steady torque. Until recently the vibration produced by this pulsating torque was regarded as unavoidable. This attitude was justified as long as these machines were built in relatively small units. However, when single-phase units of large capacity were required, the difficulties due to vibrations became a serious obstacle to the further development of the single-phase system, until a method was devised to neutralize successfully the effect of the vibrations, which might cause damage.

ON ACCOUNT of the pulsating torque developed by single-phase machines, they have a tendency to vibrate and cause trouble in the building that houses them and in adjacent structures. A successful method has been developed for preventing these vibrations by mounting the machine's stator on springs, as described in this article.

In order to explain the principle of the vibration absorber or spring mounting, the action of a standard single-phase machine will first be discussed. First consider the motion of a rotor under the action of a pulsating torque and suppose that this rotor is a part of a frequency-changer set with an unusually rigid shaft so that both rotors act as a single mass. Then when the torque is above its average value the rotor will be accelerating and when the torque is below the average there will be a slowing down of the rotor. In this way the pulsations in the torque are absorbed by the inertia reactions of the rotor. This motion of the rotor amounts to a torsional vibration superimposed on the steady rotation. Ordinarily, the amplitude of these vibrations is too small to cause any trouble. As an example, the rotor of a 20,000-kva. 600-r.p.m. 25-cycle machine has a moment of inertia of 20,000 lb.-ft.sq., which gives an amplitude of 0.019 deg. at rated kva. and 100 per cent power factor. This vibration of the rotor is usually too small to be of any consequence.

The motion of the stator represents a more complicated problem. If the foundation of the machine is ideal—that is, massive and rigid—and if the stator is rigidly connected to this foundation, then there can be no motion of the stator and the torque must react directly on the foundation. In practice it is impossible to obtain a rigid foundation. It is usually considered sufficient if the natural vibration frequency of the machine is 25 per cent or more above the frequency of the pulsating torque. This gives only a slight vibration of the stator and, so long as machines were built in small units, was satisfactory. With large units the pulsating forces acting on the foundation become so great that other parts of the power house and even other buildings may be affected. When such units are in congested districts, there are almost certain to be other objects in the neighborhood having the same natural frequency as the torque of the machine. Cases have occurred where a building two blocks away has had a natural frequency corresponding to the torque frequency and vibrated so badly that bricks fell out of the walls and the tenants had to move out. This shows that serious trouble may be caused by a large machine even though its foundation is sufficiently rigid so that the vibration of the machine itself is negligible.

With the present practice of mounting machines on structural-steel foundations, another difficulty develops. Such foundations are inherently flexible. The stiffness that determines the natural frequency for this type of vibration is difficult to calculate accurately. There are so many uncertain factors that machines are often mounted on foundations of such characteristics that a natural frequency corresponding to the torque frequency is obtained. In fact, for the larger machines being built at present, the otherwise most desirable foundation often has a natural frequency in this range. This constitutes another serious problem in the design of large single-phase machines.

It is to be expected that a problem of this nature will be rather erratic, but there are certain definite tendencies that can be noted. If a 1,500-r.p.m. single-phase turbine-driven alternator is compared with a 300-r.p.m. frequency-changer set or synchronous condenser of the same capacity, there are several reasons why the turbine-driven alternator should vibrate less. In the first place the alternating torque of the turbine-driven alternator is only one-fifth of that in the 300-r.p.m. machine. Owing to the different type of construction the alternator has a proportionately heavier stator and foundations, so that little trouble is experienced with the vibration of a single-phase alternator of this size.

Experience with 25-cycle single-phase units in synchronous condensers, frequency-changer sets and similar units indicates that there is a certain limiting capacity beyond which units are likely to give trouble when mounted in the conventional manner. This is partly explained by the increased magnitude of the force acting on the foundation, which frequently causes trouble in other structures even though the machine itself does not vibrate appreciably, but a more important

cause is resonance, which is approached in the larger machines. As the size of a machine and its foundation is increased, the modulus of elasticity cannot be increased proportionately, which means that as the size of the machine increases, its resonance frequency will decrease.

At a certain size the natural frequency of the machine will be lowered to the point where resonance will occur. When this point is reached, some radical change must be made in the design. One alternative would be to strengthen the supporting parts sufficiently to raise the natural frequency above the operating point. This would be expensive and would still leave the danger of forced vibration in adjacent structures. Another possibility is to weaken the foundation so that the natural frequency will be below the operating point, but this usually makes the structure too flimsy. The alternative that has been developed by C. R. Soderberg is to mount the stator on springs, allowing a certain motion of the stator and absorbing the pulsating torque in the inertia reaction of the stator, but shielding the bearings and other parts of the machine from the vibration.

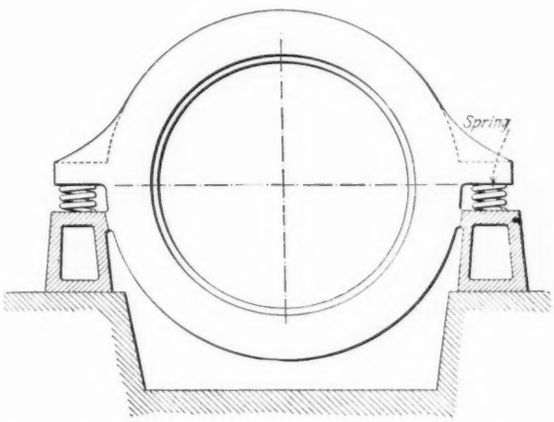


Fig. 1—Schematic diagram of spring-mounted stator

Spring-Mounted Stator

Fig. 1 is a schematic diagram of a spring-mounted stator. The springs carry the weight of the stator and enable it to rotate through small angles around its axis. The springs must have the proper characteristic to allow the stator to rotate about its axis, but restrain the stator in other directions so that the air gap will not be disturbed. The most direct method of obtaining this condition is to place the stator feet on a horizontal plane through the axis. In the standard type of machine it has been customary to place the feet below the axis. This arrangement tends to augment the vibrations and produce lateral motions of the whole machine.

There are several other possible methods. For instance, the stator could be mounted on trunnions on the rotor axis. This is not a practical solution for large units because of the large stator weight to be supported. The stator might be mounted on flexible pads of rubber, cork or some similar material. But such materials have rather uncertain physical properties, deteriorate with age and would form an uncertain support for the large stators now being built. The whole machine could be mounted on a flexible support, but this would probably give trouble from poor bearing alignment and similar things. By mounting the stator on steel springs, the springs can be designed to give the characteristics desired and can be relied on to maintain these characteristics indefinitely.

In this spring-mounted stator guiding surfaces maintain the air gap in a horizontal direction. There are no guides to maintain the air gap in a vertical direction, since it has been found that they are unnecessary, the weight of the stator giving sufficient stability in a vertical direction.

As has been pointed out in the previous discussion, there are two conditions to be remedied by the spring mounting: First, the resonance of the stator mounting must be avoided; secondly, the pulsating torque must be absorbed to avoid forced vibrations in other parts of the machine and adjacent structures.

Mechanical Construction of the Springs

The most difficult part of the development was to get a satisfactory spring support that would have the desired flexibility for the torsional motion of the stator and yet hold the stator rigidly in other directions. Fig. 1 is a schematic diagram showing the location of the springs, which support the weight of the stator so that a certain torsional motion is allowed. For simplicity the springs are shown as the conventional coil type, although actually beam springs are used, as shown in Fig. 2. Stationary guides restrain the stator in both horizontal directions, but it is free to move vertically, consequently the natural frequency in a vertical direction must not coincide with the frequency of any impulse that might act on the stator.

In selecting the type of spring, the following conditions determine the choice: First, the rigidity (spring constant) of the spring is determined by the cushioning effect required. For example, the usual transmitting effect allowed is 10 per cent. This requires a natural frequency of the stator not over one-third of the torque frequency. For a 25-cycle machine the torque frequency is 50 cycles, so that the natural frequency of the stator must be equal to or less than 16⅔. Since the moment of inertia of the stator and point of support are fixed for a given machine, the spring must be designed to give the required natural frequency, which means that the spring must have a certain predetermined flexibility. Then the weight of the stator plus the torque transmitted to the foundation must be

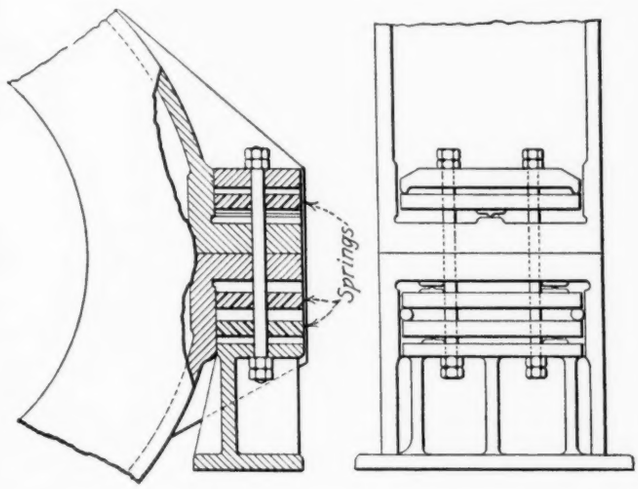


Fig. 2—Arrangement of springs under the stator's feet

carried by a spring of a predetermined stiffness. This determines the potential energy which must be absorbed by the spring without exceeding the allowable stress.

It is a well-known fact that a cubic inch of a given material, when stressed uniformly, will absorb an amount of energy proportional to the square of the stress and inversely proportional to the modulus of elasticity. Then, since the maximum allowable stress is fixed, a spring should be selected in which the material is stressed as uniformly as possible and which will fit into the available space.

A coil spring is efficient in terms of the potential energy absorbed per pound of material, but it would occupy too much space for this application. In a beam spring loaded at two points, the material is worked quite efficiently, since the stress is constant along the length between the two points at which the load is applied. The position of these supporting points is important. It has been found that there is a certain position that requires the minimum width of spring, and usually the width of the spring is one of the principal limitations, so this generally determines the position of the loading points.

Fig. 2 shows the arrangement of springs as used for some of the larger units. From this it will be seen that the weight of the stator rests on eight flat beam springs (four on each side). There are four springs holding the stator down. These four holding-down springs are detrimental from the viewpoint of cushioning effect,

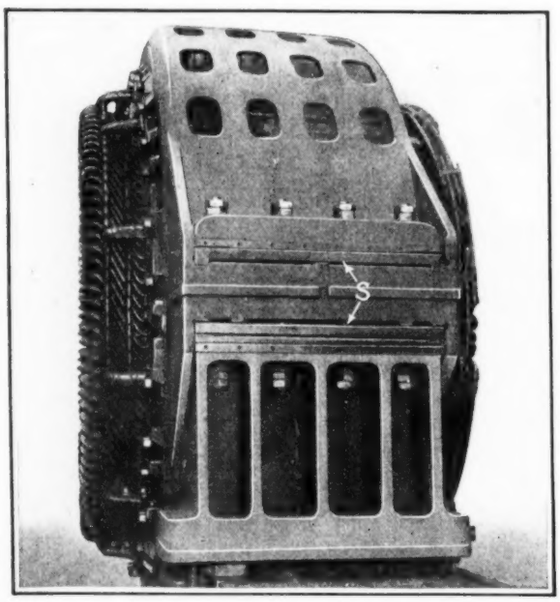


Fig. 3—Single-phase 7,500-kva. 300-r.p.m. machine mounted on springs

but are considered necessary in case of a heavy short-circuit.

The upper springs are made identical with the lower ones, so that in case a lower spring breaks, an upper one can be used to replace it until a new spring is secured. However, the possibility of a broken spring is remote, as the service to which the springs are subjected is not nearly so severe as would at first be expected. The variable part of the stress is small in normal operation. The torque force is generally less than 20 per cent of the total load on the springs. Then if the transmitting effect is 10 per cent, the variable part of the stress is only 10 per cent of 20 per cent, or 2 per cent of the total stress, so that if the maximum average stress allowed is 35,000 lb. per sq.in., the variable component is only ±700 lb. per square inch.

In case of a surge or short-circuit heavy forces might act on the springs if they were perfectly free, but solid

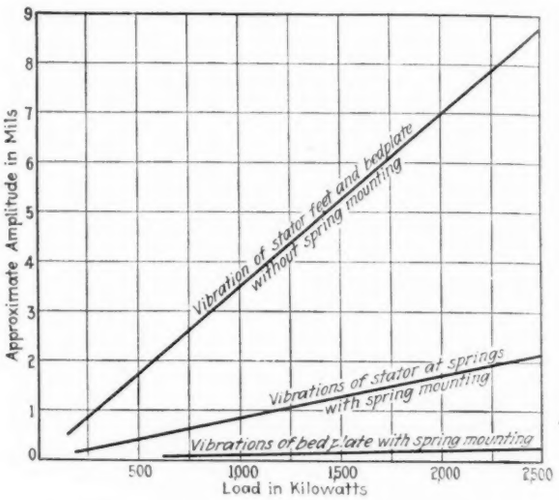


Fig. 4—Test results, obtained from a machine with spring-mounted stator

supports are provided so that when the stress reaches a certain allowable value, the centers of the springs strike a support, thus increasing their stiffness and limiting the maximum stress. This is another advantage of the type of spring selected.

In some small machines only four supporting springs are required instead of eight, as shown in Fig. 2. Fig. 3 depicts a 7,500-kva. 300-r.p.m. single-phase machine with a spring-mounted stator.

Fig. 4 shows the test results for one of the first machines to which this type of mounting was applied. The foundation was such that the machine was operating in the resonant range, the amplitude of the stator being approximately four times the hypothetical free motion of the stator. The pulsating force transmitted to the foundation under these conditions was approximately five times the normal alternating torque of the machine. With the spring mounting, the motion of the stator was decreased to one-fourth of its original value and the alternating force transmitted reduced to 10 per cent of the pulsating torque, or only 2 per cent of the original value. Another advantage of this mounting is the decreased shock to the mechanical parts in case of a surge or short-circuit. With this mounting the stator is allowed to yield slightly under the sudden force produced, so that the stresses resulting are materially lower.

WATER CAN BE EVAPORATED by exhaust steam if, for example, the water is contained in a closed vessel and the steam introduced into a set of coils. The vapor or steam given off by the body of water must be removed at a rate such that the existing pressure in the vessel is less than that of the exhaust steam. In this way the temperature of the evaporating water is kept lower than that of the exhaust steam.

High-Pressure Steam Engine for German Paper Mill

By C. H. S. TUPHOLME

THE tendency so evident in the United States, to superimpose high-pressure boilers and engines on existing low-pressure installations likewise exists in European countries, with the exception that there the new prime movers frequently are reciprocating engines.

F. E. WEIDENMULLER A-G., of Dreiwerden, Saxony, employing four steam engines in its paper mills at Antonsthal and Dreiwerden, recently planned an extension of the Antonsthal plant which would entail increasing the power of the steam engines from 800 to 1,600 hp. Simultaneously with this extension of the power plant, the firm contemplated raising the steam pressure in order to have a modern plant with the lowest possible steam consumption.

For the extension of the power plant four different projects were considered:

1. Retaining the existing triple-expansion steam engine and acquiring an additional engine. The existing unit developed normally about 800 hp. and operated with steam at an initial pressure of 155 lb. per sq.in. The new engine would also have to develop about 800 hp. and the exhaust steam from it would be used to heat the paper machines. The total amount of steam required was estimated at around 26,500 lb. per hour.

2. Installation of a new boiler with an operating pressure of about 425 lb. per sq.in. The existing triple-expansion engine would then be modified to allow it to work with an initial pressure of 400 lb. and a new engine to operate with steam of 400 lb. pressure would be installed. By raising the boiler pressure, the steam consumption would be reduced to about 18,700 lb. per hour.

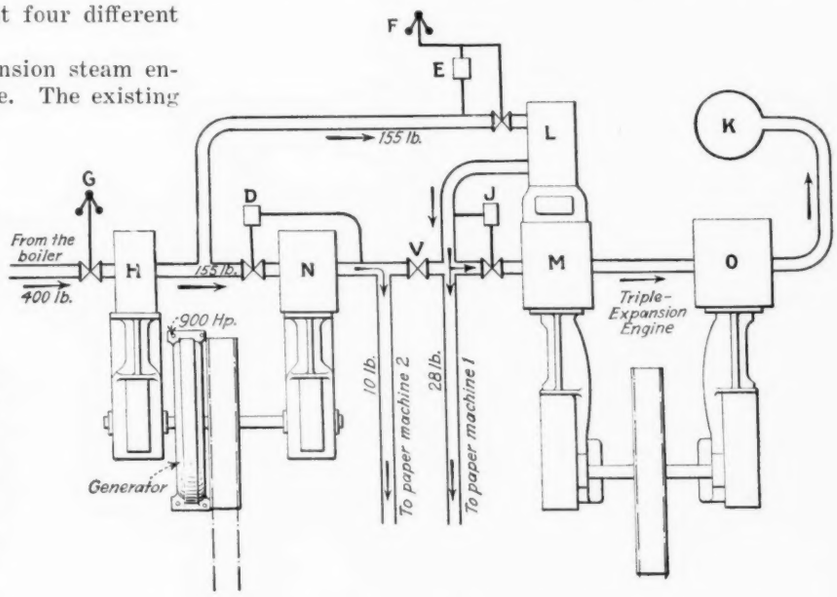
3. Installing a new steam engine or a steam turbine capable of developing the total power required, 1,600 hp., with steam extracted for heating the paper machines.

4. Retaining the triple-expansion steam engine to work at the original initial pressure of 155 lb. and installing a primary steam engine for an initial pressure of 400 lb., using the exhaust steam from the latter to drive the triple-expansion steam engine.

The last plan complied best with the requirements of the mills. It would also cost less than either of the others and would give the lowest steam consumption—about 17,600 lb. per hour for the total output of 1,600 hp.

An order was accordingly placed for a cross-compound steam engine developing normally 900 hp. and working with steam at an initial pressure of 400 lb. per sq.in. and an initial temperature of 660 deg. F. The high-pressure cylinder of the primary engine is partly of cast steel and is fitted with inlet and exhaust valves at both ends. Both cylinders have a stroke of 24 in., the high-pressure cylinder having a 17-in. and the low-pressure cylinder 21-in. bore. The engine runs at 165 r.p.m. and can develop continuously a maximum of 1,100 b.hp., the normal rating being 900 b.hp. It is direct-coupled to a 500-kw. direct-current dynamo, but part of the power is transmitted to shafting through a belt from the flywheel. The triple-expansion engine is also connected to this shafting.

The amount of heating steam required for paper machine No. 1 is about 3,500 lb. per hour at 28 lb. per sq.in. and for machine No. 2, about 6,600 lb. per hour at 10 lb. per sq.in. The primary engine receives steam at 400 lb. per sq.in. and 660 deg. F. from the new high-pressure boilers. The high-pressure cylinder *H* is fitted with a standard speed governor, and the steam leaving this cylinder at a pressure of 155 lb. per sq.in. is supplied partly to the low-pressure cylinder *N* and partly to the triple-expansion engine *L* as indicated in the illustration. The valve gear of the low-pressure cylinder of the primary engine is connected with a Sulzer steam regulator *D* which limits the amount of steam



Arrangement of engines and piping in a German paper mill

admitted to this cylinder to the amount required for heating paper machine No. 2. The pressure of the heating steam in this paper machine is therefore kept constant at 10 lb.

The existing triple-expansion engine receives steam at 155 lb. extracted from the primary engine. The high-pressure cylinder *L* of the triple-expansion engine is fitted with a standard speed governor *F*, the speed adjustment of which is controlled by a steam-pressure regulator *I'* so that the cutoff of the engine is increased when the pressure of the steam rises and is decreased when the pressure falls. The steam-pressure regulator therefore insures the steam pressure to this engine being kept at 155 lb.

The steam issues from the high-pressure cylinder of the triple-expansion engine at a pressure of 28 lb. and passes partly to paper machine No. 1 and partly to the intermediate-pressure cylinder *M*. The valve gear of the intermediate cylinder is also connected with a steam-pressure regulator *J* which allows only the steam not required by paper machine No. 1 to pass into the intermediate cylinder, and therefore insures the pressure of the heating steam being maintained at 28 lb. From the intermediate cylinder the steam passes as usual through the low-pressure cylinder *O* and then to the condenser *K*.

The steam piping is so arranged that the triple-expansion engine can be operated with steam at 155 lb. from the existing boiler, but this is omitted in the illustration.

It is also possible to take steam at 28 lb. from the triple-expansion engine for use in paper machine No. 2 as well as the steam for paper machine No. 1. For this purpose a special hand-operated valve *V* is provided. This is to be replaced later by an automatic valve operated by oil under pressure.

Connecting the two steam engines together and the proper adjustment of the steam-pressure regulators permit the plant to meet both the power and the heating requirements of the paper mill under all the different conditions of working and insure the maximum economy.

In case paper machine No. 1 is temporarily out of service, the pressure in the 28-lb. heating steam pipe will rise and the pressure regulator on the intermediate-pressure cylinder of the triple-expansion engine will consequently increase the cutoff. The power developed by this engine therefore increases, although the demand for power has decreased because of paper machine No. 1 being stopped. The excess power is transmitted through the shafting to the primary engine and reduces the cutoff to the high-pressure cylinder of the latter. The pressure in the 155-lb. steam pipe of the primary engine therefore falls and the pressure regulator of that pipe comes into action and reduces the cutoff of the high-pressure cylinder of the triple-expansion engine. When the cycle of operations is completed, the power developed by the two engines has been reduced by the amount required for driving paper machine No. 1 without any appreciable change in the steam pressures.

If, on the other hand, paper machine No. 2 is stopped, the pressure of the heating steam at 10 lb. rises slightly and the pressure regulator on the low-pressure cylinder of the primary engine sets the cutoff to a smaller amount. The speed regulator also reduces the cutoff of the high-pressure cylinder of the primary engine, since the demand for power has fallen owing to paper machine No. 2 being stopped. Consequently, the pressure in the 155-lb. pipe falls and the pressure regulator to the speed governor of the triple-expansion engine reduces the cutoff in order to prevent the pressure in the 155-lb. pipe falling farther. When the cycle of governing operations is completed, both engines are developing less power without the pressures in the steam pipes having undergone any sensible alteration.

In order that the governing described may be carried out, very accurate steam-pressure regulators are required. They are operated by oil under pressure, which is taken from the lubricating oil system of the engines; the force they exert on the valve gear is independent of the magnitude of the variation in steam pressure and depends only on the height of the oil pressure and the diameter of the servomotor pistons.

Finding Out What You Know*

Ans. 1—If the compression is not at the best point in consideration of the inertia forces of the reciprocating parts, the pressure on the piston approaching dead center may become negative and the crank must then pull the piston to the end of its stroke and across dead center.

Ans. 2—A multi-stage turbine of large or moderately large size should not ordinarily be run at loads as low as 10 per cent of its rating, because there would be insufficient steam passing through the low-pressure buckets to keep them cool. Windage losses, which are simply the work done against friction, are dissipated as heat, and this must either be carried off by the steam or it will raise the temperature of both steam and buckets to a dangerous point. In addition to this, operation at low loads is likely to result in non-uniform temperature distribution, when higher loads are picked up. This may cause the machine to vibrate.

Ans. 3—The cycles of an alternating-current generator are found as follows:

$$cycles = \frac{r.p.m.}{60 \times no.\ pole\ pairs}$$

In the example, $60 = \frac{3{,}600}{60 \times \text{no. pole pairs}}$ or there is one pair of poles, or two poles.

Ans. 4—A soft patch is a plate placed over a defect in a boiler sheet and is drawn into place by patch bolts after an application of red lead.

Ans. 5—Tests run on a water-tube boiler indicated that the temperature difference did not exceed 5 deg. F.

Ans. 6—Approximately 13 pounds.

Ans. 7—The pressure exerted by one foot head of liquid ammonia is approximately 0.25 lb. per sq.in. The 100-ft. elevation will exert a pressure of 25 lb., much under the receiver pressure. The only effect will be to cause the pressure at the brine cooler expansion cock to be lower, which does no harm.

Ans. 8—None. The valve must admit steam at dead center and continue to do so for the full stroke.

Ans. 9—If P_1 be the suction pressure, P_2 the discharge pressure, P_3 the immediate pressure, all in pounds per square inch absolute,

$$P_3 = \sqrt{P_1 P_2}$$

Ans. 10—The mixture is so lean that it will not fire in the cylinder and accumulates in the exhaust until the mixture becomes rich enough to fire, which may happen when both exhaust and inlet valves are open. Leaky valves may also permit the flame to blow out into the carburetor.

*The questions will be found on page 908.

Tailrace Used To Obtain Test Load On Hydro-Electric Unit

By C. R. REID*

IT WAS desired to make some tests on a 30,000-hp. waterwheel which was direct-connected to a 25,000-kva. 60-cycle generator. These tests were to be at different speeds. It would have been possible to provide a non-synchronous load on the system for this test, but it would have tied up lines and apparatus that were needed for operation. This generator is connected to a bank of three 10,000-kva. transformers with a ratio of 6,600 to 63,500 volts. Selector switches are provided

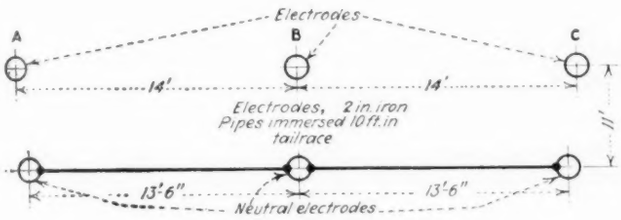


Fig. 1—Shows spacing of the electrodes

on the high-tension side to connect the unit to either one of two 60,000-volt buses through the unit's oil switch.

Electrodes of 2-in. iron pipe were installed in a quiet part of the tailrace with a spacing as shown in Fig. 1. The initial immersion of the electrodes was 10 ft. and provision was made for adjustment, as shown in Fig. 2. In this figure *A*, *B* and *C* are the load electrodes. A set of neutral electrodes was installed and connected together as shown. These were to keep the leakage current out of the reinforcing of the power house. A three-phase line with aluminum conductors was run through a spare line entrance from No. 2 busbar, across the power-house roof and down the tailrace wall to the electrodes, as shown in Fig. 2. The linemen, in installing the electrodes, spaced electrode *C* only 11 ft. 6 in. from *B*, while *A* was spaced 14 ft. from *B*. However, when the voltage was built up on the electrodes, the load was well balanced. The following is a set of readings taken from the switchboard instruments on the generator at this time: Kilowatts, 22,000; volts, 6,840; amperes—phase *A*, 1,900; phase *B*, 1,950; phase *C*, 1,900.

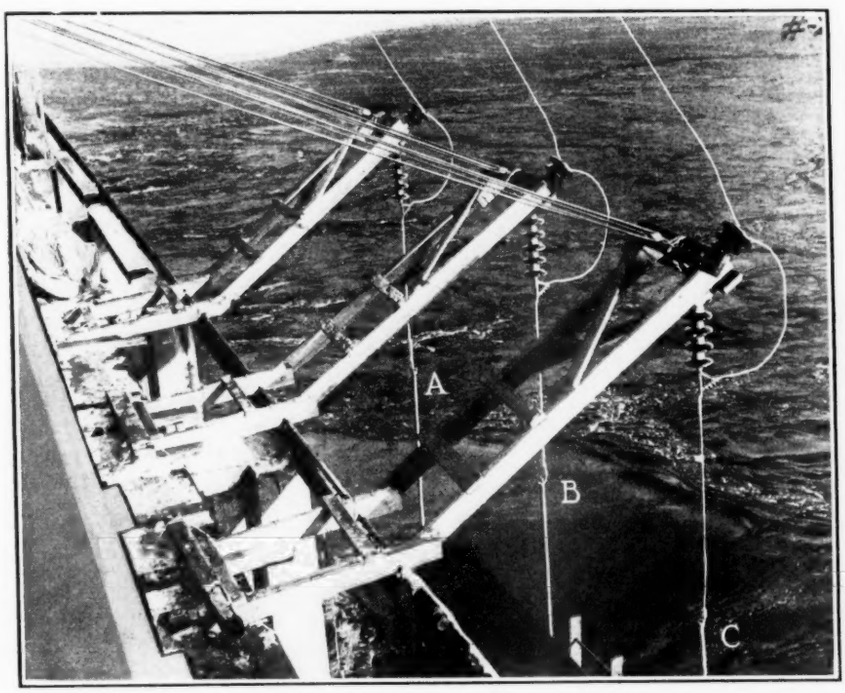


Fig. 2—Method of supporting the electrodes in the tailrace

The load was quite steady on the unit even though the electrodes were moved around considerably by the eddies in the tailrace. The bottom of electrode *C* was carried toward *B* so that the spacing at times could not have exceeded ten feet. Twice during a ten-minute observation after nightfall, a spark discharge took place apparently between the lower ends of *B* and *C* electrodes. Slight spark discharges took place from the electrodes at the surface of the water. The electrodes were respaced in accordance with the dimensions shown in Fig. 1 and used with entire success in carrying out the tests on the waterwheel.

The temperature of the water was one or two degrees above zero centigrade while these tests were being made. If these electrodes were used in the summer time with the water at a higher temperature, less immersion would be required to provide full load on the unit. The performance of these electrodes at 60,000 volts was so satisfactory that there is good reason to believe that such an arrangement might be successful on any operating voltage used at the present time. Very high voltages might require certain modifications to the form of the electrodes in order to eliminate spark discharges. The advantages of such an arrangement over the usual water-box or rheostat directly connected to the generator are that it is less expensive, more quickly installed, and more reliable in operation.

*Power-house superintendent, Shawinigan Water & Power Company, Shawinigan Falls, Quebec.

Organized Routine Helps the Operator

BY CHARLES H. SMITH
Instructor in Mechanical Engineering,
Leland Stanford, Jr., University

SYSTEMATIC checking of important items helps the plant operator to know what is going on in his plant and makes it easier for him to avoid interruptions and waste of fuel. The author tells how one operator set up a routine to help him direct his work intelligently

PLANT routine, although seldom mentioned, is perhaps one of the most important factors in determining the efficiency and economy results obtained by any power plant. It is hoped that the reader may obtain from this article some insight of the importance of this item in the plant described and perhaps receive suggestions that may prove valuable for other installations.

The plant under discussion consists of twelve 7,130-sq.ft. boilers which furnish steam to one 7,500- and three 6,000-kva. generators for supplying current principally for mine, smelter and plant use. The plant at times acts as a stand-by for one of the power companies in the vicinity, while at other times electrical energy is purchased from the same company. The boilers are all fired with oil, using steam-atomizing back-shot burners. Economizers are installed on each boiler and natural draft is utilized exclusively. Normal steam conditions are 210 lb. per sq.in. gage pressure and 115 deg. superheat. Between twenty-five and thirty thousand pounds of water per hour per boiler are evaporated. The steam from these boilers is used primarily for the turbine units. Steam generated at 35 deg. superheat and 210 lb. pressure by waste heat boilers at the smelter is used for the most part in a battery of four blowing engines that furnish air to the smelter at 14 lb. pressure. Some of this steam is also used in oil transfer operations; that is, unloading cars and pumping oil to storage or to smelter or boiler tanks.

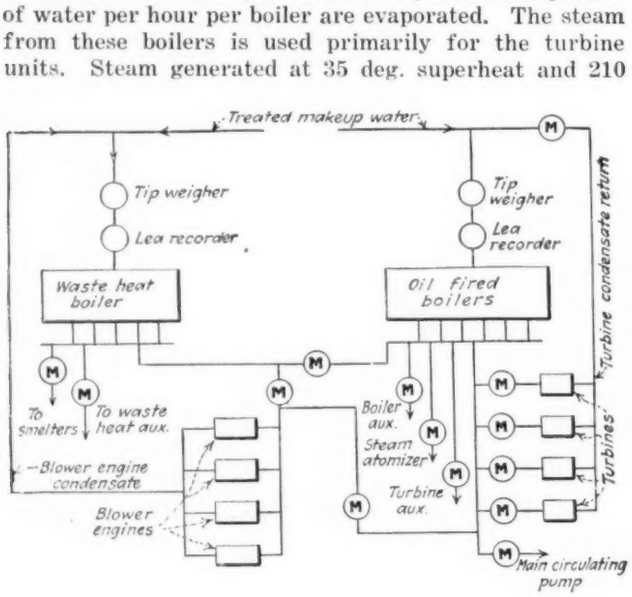


Fig. 1—Flow meters record distribution of steam between power plant and smelter, and to individual machines

M indicates flow meters.

Since the smelter and the power plant do not belong to the same company, the smelter is charged for oil-generated steam used in the engines, and credited for all the steam furnished to the power plant by the waste-heat boilers. It is also necessary to know just how much steam is being used for various electrical loads so that the proper charges may be made.

In order to obtain data for making these charges and credits for the various supplies and demands of steam, a number of indicating, recording and integrating flow meters are installed as well as recording pressure gages and thermometers. Fig. 1 shows the location of the flow meters in a schematic piping layout. The recording thermometers and pressure gages are mounted adjacent to indicating types of instrument so that they may be checked at intervals. With this information set forth the shift, daily, weekly and monthly routine may be better explained.

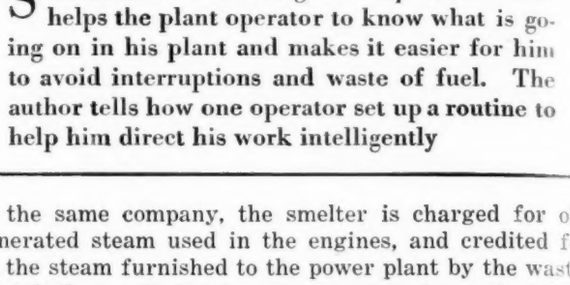

Shift 1
Boilers on line 1 2 5 6 8 1 5 0 0 0 0 lb. per hour
Boilers 3 12 add. steam 5 min. 6 0 0 0 0 " " "
Boilers 11 " " 30 " 3 0 0 0 0 " " "
Boilers 4 7 " " 50 " 6 0 0 0 0 " " "
Total steam in 60 min. 3 0 0 0 0 0 " " "
Boilers out for cleaning or repairs 9 10
Feed pump on line 2

Fig. 2—The boiler-room log board carries numbered brass checks

Spare checks are kept at the top.

Shift and Daily Routine

When a fireman comes on duty, his first job is to examine the logbook for any notes of importance from the preceding shifts. He then checks over data on a log board placed over his desk. This board is laid out about as shown in Fig. 2. The numbers are changed by placing metal tabs with printed numbers on properly spaced nails or hooks. The power-room engineer has a similar logbook and board, the notations on the latter, however, being given in terms of the load in kilowatts and load increases in kilowatts which may be handled in 5-, 30- and 50-min. periods. Each hour after coming on duty, these men make a round of their respective plants, reading and logging data from gages, meters, etc., which will furnish data for working up a boiler and power-house efficiency report.

The data taken in the boiler room are readings of oil used, determined by a stick gage, steam temperature

and pressure in headers; feed-water temperature; total water used; and steam to auxiliaries and burners. The water used is measured by means of a float recorder and may be checked by a tipping weigher equipped with a counter.

This weigher is operated in series with the recorder float tank. The oil used by each boiler may also be determined from an ordinary counter type of liquid meter installed in the pipe leading to each boiler burner line. These meters are read when warming up a boiler to be placed in service, the oil so used being deducted from the day's total and charged to this special item.

Once each shift an oil sample of about 250 c.c. is taken from the feed line at the pump. This sample is sent to the plant laboratory daily where it is thoroughly stirred and a test sample taken. This test sample consists of 1 c.c. for every 10 barrels of oil used. The test samples are kept in a jar, and after every ten days' accumulation a calorific test of the oil is made. A fresh sample is then started and the cycle is repeated. With the exception of the oil readings the water tender at the waste-heat boilers has a log similar to the one previously described.

In the power house hourly logs of pressures, vacuums, oil temperatures on turbines, circulating-water temperatures to and from each condenser, and various load readings are taken. Weather readings are also taken by the power-house engineer.[1] These include wet- and dry-bulb temperatures, barometer reading, wind speed and direction, condition of the sky, and rainfall if any. These latter observations are made every three hours, except the rainfall, which is measured but once a day. These data, together with those taken in the boiler rooms, are delivered to the power-plant office each morning. A report of the oil received and its disposition (to smelter, boilers or storage) is also turned in daily. Boiler efficiencies and plant efficiencies are then computed and the kilowatt-hours per barrel of oil are determined. Before any calculations are made, however, the data obtained from the various sources are compared with the recording charts, which are changed and filled daily.

With the instruments installed, the amount of steam supplied to any particular set of machines may be determined and the variations of temperatures and pressures throughout the day readily seen.

Daily checks are made on the tipping weighers to see that they are in proper adjustment, and tests are made to check the soda-ash treatment of water fed to boilers and plant locomotives. Cooling-pond water is tested daily for carbonates.

Weekly Routine

The more important weekly tests are those made on the water samples taken from each boiler in operation and from condensers on each of the turbines and blowing engines. An analysis is also made of the pond water to determine the amount of total solids and volatile solids carried therein. From the tests of boiler and pond water the amount of blowdown for the next week is determined, and if extreme conditions are found by the first test, a check is made the following day. The condensate tests are made in order to determine whether the condensers are tight, a sulphate reaction showing leakage. Tests of the boiler waters and condensates are made with silver nitrate by the titration method and pond water solids are determined by evaporation in a platinum dish.

Other weekly tests consist of checks on header pressure gages, by means of a test gage; header temperature checks by means of a thermometer arranged for stem correction; and an examination, cleaning and adjustment of all draft gages and a mechanical CO_2 recorder. A comparison is also made of all the recording thermometers, pressure, and vacuum gages already mentioned, with their respective indicators and with standard pieces of apparatus.

As previously mentioned, tests are made each ten days on the fuel supplied to the power plant. These tests are carried out with a bomb calorimeter, correction being made for acid formed, radiation, and thermometer stem emergence. At the same time the oil is tested for moisture and bottom settlings by a centrifuge method and its specific gravity is checked. Additional oil tests are made monthly. These consist of tests identical with those already described under the ten-day cycle, but performed on samples of the oil taken at the oil transfer station during the transfer operations each day. These tests serve as a check on the boiler-room sample determinations. Oil in storage is measured each month by means of a tape to check the calibrations on the tank indicator, allowance being made for temperature variations.

Each flow-meter line is blown down once a month and the zero reading of the pen and indicator are checked. Every three months each flow meter is recalibrated after being thoroughly cleaned, and a check is made of the accuracy and consistency of the integrator mechanisms.

With this program of routine tests and checks the plant is kept running smoothly and the boiler efficiency is maintained close to 82 per cent, with a corresponding high standard of plant operation in general.

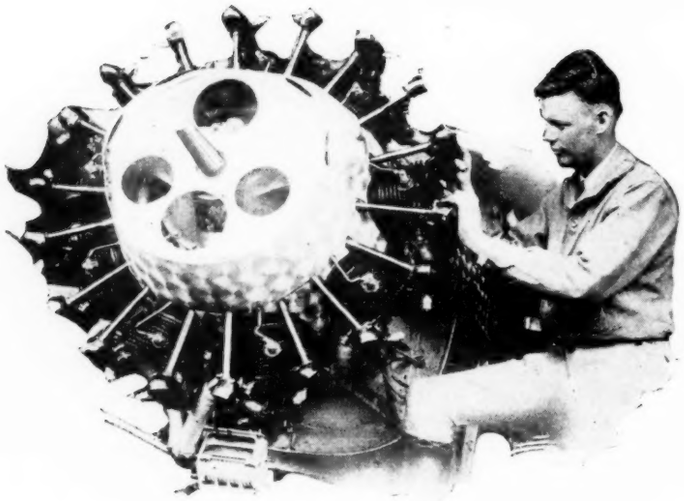
Overloads Decrease Efficiency

At zero load on an electrical machine the efficiency is zero and increases as the load increases. This continues only to a certain value of load, beyond which the efficiency begins to decrease. This change from an increase is due to the relation between the losses that are constant and those that vary with the load.

For example, take a 5-kva. transformer—the iron losses are about 40 watts, which are practically the only losses present at no load. Assume the full-load current to be 25 amperes and the resistance of the winding 0.18 ohm. The full-load copper losses are equal to the square of the current in amperes, times the resistance in ohms, or $25 \times 25 \times 0.18 = 112.5$ watts. Then the total input to the transformer is $5{,}000 + 40 + 112.5 = 5{,}152.5$ volt-amperes and the per cent efficiency equals $(5{,}000 \times 100) \div 5{,}152.5 = 97$.

If the load is increased to 50 amperes, the copper losses will increase to $50 \times 50 \times 0.18 = 450$ watts; although the load on the transformer has only been doubled, the copper losses have increased four times. The iron losses will remain practically constant, so that the total input to the transformers will be $10{,}000 + 40 + 450 = 10{,}490$ volt-amperes, and per cent efficiency is $(10{,}000 \times 100) \div 10{,}490 = 95.33$. Thus the efficiency has been reduced by 1.66 per cent when the load was increased 100 per cent. The foregoing neglects the voltage drop at the transformer terminals.

[1] Weather observations are made in co-operation with the United States Weather Bureau.



First Power Plant To Fly From New York to Paris

THE reliable power plant upon which Lindbergh depended to drive his Ryan monoplane from New York to Paris is the result of seven years of design, test and practical operation. By estimate this Wright "Whirlwind" engine made 3,650,000 revolutions in its unbroken journey across the Atlantic.

This engine is of the radial, nine-cylinder, air-cooled type, and is rated at 200 hp. at 1,800 r.p.m. The piston diameter is 4½ in. and the stroke is 5½ in. It consumes 9 to 12 gallons of gasoline and 2 quarts of oil per hour.

In the older type radial engine the cylinders revolved around a fixed crank shaft, the propeller being bolted to the crankcase. On the present type the cylinders are stationary and the crankshaft revolves. The design of the shaft and connecting rods differs from automobile practice in that there is one master connecting rod to which all other connecting rods fasten.

EDITORIALS

F. R. LOW, EDITOR

Technical Books Wanted

"OF MAKING many books there is no end"—technical books as well as others. Many engineering books, recent and older, are of excellent quality, but the available books are not well balanced as to subject. In some fields there are too many of them, while in other fields there is a dearth of book literature.

A large number of the technical books published each year are intended for use in schools and colleges and are rather elementary or theoretical in character. This seems particularly true of those dealing with heat engines and their applications. American power-plant design has developed rapidly in recent years. New forms of equipment, such as water-cooled furnace walls, air preheaters and bleeder turbines have necessitated new methods of calculation and design. Boiler ratings and boiler control have assumed new aspects. One looks in vain through the lists of new books for a good comprehensive text on modern power-plant design, on new boilers, furnaces and auxiliaries, on bleeder steam turbines and their auxiliaries, or on internal-combustion engines. Nor are there any comprehensive texts on heat-balance calculations for power stations.

Each of these subjects is of the greatest importance to power-plant engineers, and the right book would find ready purchasers. Such books cannot be written by college professors who do not have contact or experience on the design and operation of modern plants. Practicing engineers who have the necessary qualifications are usually too busy to do this work. Yet the profession loses much by not having available the ideas and methods of those leaders. Some way should be found to provide these men with the time needed to write their books in order to further the best interests of the power-plant industry. Possibly joint authorship by the experienced engineer and the professor who can write well, may be the proper way of preparing such texts. Such technical books are wanted now.

Testing Steel Castings

AN INTERESTING discussion of the phase of the papers on experiences with high pressures which were presented at the Spring Meeting of A.S.M.E., was the generally unsatisfactory state of the art of making sound, reliable, steel castings. In one paper it was pointed out that satisfactory castings were secured only after careful X-ray examinations and the rejection of all those showing faults. The other paper states that defective steel castings have caused no end of trouble in the particular plant under discussion and there is yet to be found a line of fittings that will stand the service. Other speakers intimated that defective steel castings were all too common. It was also stated that new stations are designed with a minimum of fittings to lessen the troubles with steel castings.

This discussion suggests that if steel castings must be used, engineers should develop some standard test that may be readily applied to these parts and that will indicate whether the casting is now defective or will develop pinholes or other flaws at a later date in service. The X-ray method seems to provide such a satisfactory test, but is expensive to set up and to operate. The cold-water pressure test ordinarily applied to cast-iron fittings does not indicate those defects that later develop in use, such as pinholes and hidden flaws. Some engineers have insisted on hot-water pressure tests. If very hot water is used, the results have been reported to be satisfactory. The increased temperature opens up the metal structure as a result of its expansion and the small hidden flaws, cracks and pinholes are more readily detected. The hot-water test is difficult to make and results in a higher percentage of rejected castings, and manufacturers have been reluctant to standardize on this test.

Apparently, the first step to remedy this trouble with steel castings is for engineers to determine what test will positively reject all castings that will fail to meet any service conditions. Increased rejections should encourage steel founders to conduct research into better casting methods. This would tend to cheapen production and would stop the apparent drift from castings to the use of welded or forged fittings.

Every purchaser of steel castings for use in steel piping should insist on most careful inspection and test before accepting these castings for erection in the plant. This is necessary to save himself expense and trouble later, when the steel castings are in service.

Vibration in Steam Turbines

MUCH progress has been made during the last few years on the determination of the causes of vibration in turbine and generator rotors and in the development of means to eliminate a greater portion of these vibrations. It is now possible to build and balance such high-speed rotors so that the vibration is negligible and should produce no harmful effects over the useful life of the turbine.

These studies of vibration have directed the attention of designers and operators to the fact that every high-speed part of a machine has certain natural periods of vibration at certain speeds. These periods of vibration depend on the size, shape and weight of the given part and on its relative speed. Small vibrations in different parts may combine at a given instant to produce a harmonic vibration of a greater magnitude than either alone.

Studies have been made on turbines as installed in various plants in an attempt to determine why a machine that is properly designed should develop vibrations when erected. It has frequently developed that a portion of the trouble is due to vibrations in the

foundation. Tall steel foundations may act like a huge tuning fork and may have certain periods of vibration which form harmonics with some of the smaller vibrations in the revolving parts. This has been particularly noticeable where portions of the steel work supporting heavy loads was overhung or cantilevered beyond the vertical supports. The results of these tests indicate that too much care cannot be taken in designing the foundations for turbines and that the tendency to vibration of steelwork must be given thoughtful consideration. Many steel foundations are in service that have never given any trouble from this source. Possibly, a study of the details of these and of those in which vibration has occurred would reveal the causes of the trouble and indicate how it may be cured. Some designers insist on encasing the steel with concrete, but is this necessary?

Power-Plant Equipment Obsolescence

WHEN to replace obsolete equipment, or when equipment is obsolete, is one of those questions to which there are about as many answers as there are operating conditions. In an industrial power plant that operates non-condensing and has use for the exhaust steam during part of the year only, high-grade steam engines may never become obsolete provided they are properly installed, maintained and operated. Such engines have been in service for twenty-five years or more and are now in as good condition as when installed or better. Furthermore, so far as can be predicted at the present time, it is not likely that improvements in steam prime movers will make these engines obsolete. There is always the likelihood of power rates making it economical to shut them down and purchase power instead of generating it. This, however, is somewhat different from having a machine made obsolete due to the development of an improved type of equipment.

Conditions may so affect the economy of the whole plant as to make it appear economical to shut it down. One such condition is the use of inefficient steam-driven auxiliaries, where motor drive should be applied. A steam-driven pump may require eighty to one hundred pounds of steam per horsepower-hour, where the same power can be produced by the main engines of the plant on one-quarter to one-fifth this amount. In one plant, which was considered practically obsolete, changing from steam to electric drive for the auxiliaries and refrigerating equipment and making other improvements, cut the steam consumption over fifty per cent. Improvements in the boiler plant reduced the fuel consumption by an even greater percentage. The original boilers and engines are still in use producing power cheaper than it can be purchased. In this case the plant was made obsolete and inefficient by the type of auxiliary and other drives, which should never have been installed. When these were corrected, the plant was as economical as any installation could be, operating under the existing conditions.

In many cases where steam-driven auxiliaries are installed in non-condensing plants where all the exhaust cannot be used in the heating system, it is frequently a case of poor engineering and a holdover from the old idea that it did not make any difference how much steam the auxiliaries used as long as the exhaust could be absorbed in heating the feed water. So far as the auxiliaries are concerned, this idea is practically true, but how much more steam is the main engine exhausting to the atmosphere as a result of the inefficiency of the auxiliaries? An efficient power plant can be designed only when the whole process of power generation from the coal pile to the busbars is considered, with the object of supplying a unit of power at minimum cost consistent with reliability. High efficiency in any part of the process is of little account and leads to early obsolescence if it does not contribute toward keeping the cost down at the switchboard.

The Power Plant Needs An Efficiency Engineer

REGARDLESS of the scorn the term "efficiency engineer" arouses in unthinking quarters, the power plant needs one to arouse the management to the possibilities of savings.

Not so many years ago the average factory produced manufactured goods without any definite knowledge of how the existing costs compared with possible ones. A class of men arose who termed themselves efficiency engineers. These sold to managements the idea of operation study, and in a short time, through rearrangement of machinery, time studies, bonuses and the like, the cost of manufacturing dropped surprisingly. That this country can produce automobiles and other machinery with high-wage workmen at a cost that permits underselling in the world's markets is due primarily to the work of the much ridiculed efficiency men.

For some reason efficiency studies seem to have been limited to the processes, and the power plant has been left alone to struggle along in a more or less groping fashion. If an energetic power engineer essayed to initiate a complete cost system, he met with but slight encouragement from those higher up. Even now, the idea seems to be prevalent that the price paid for coal, packing and other supplies should be held secret in the treasurer's archives, and without knowledge of item price, no engineer can hope to find out either present or possible costs. Unfortunately, the plant engineer is not enough of a salesman to put over the idea, and in many instances has not the training that would enable him to set up a set of performance standards for the plant in his charge.

An efficiency engineer, even if he were consulting engineer in disguise, could enthuse the management over the huge savings to be made in the power end. His mass of charts and graphics would so enthrall the board of directors that even though not understanding what it was all about, they would be willing to make any and all changes necessary in the plant.

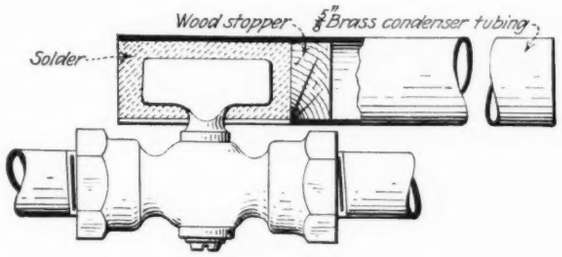
At this point the operating engineer can either make his work take on a new dignity or permit it to be lowered to a point that he is a mere job holder. Most men resent the intrusion of outside intelligence, and plant engineers are not entirely free from this defect. When the consulting engineer appears on the premises, he should be greeted with more than an open mind. The plant engineer should hold nothing back and lend every assistance in the effort to find where the plant is deficient. Such co-operation will prompt the consultant to listen to suggestions and in the end will convince him, and through him the management, that the chief engineer has ability and merely needs the co-operation of the executives to make plant savings.

Ideas From Practical Men

Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted

A Permanent Stopcock Handle

The illustration shows a handy and practical way to make handles for small stopcocks that have to be used regularly. It avoids the necessity of keeping a pair of pliers or wrench around with which to tighten the cock. Few cocks of this type can be kept free enough to turn with the fingers, and in the case of a hot line it cannot be touched. The cocks on small



Handle for small stopcock made from condenser tubing

¼-in. regulator lines on air compressors, for instance, have to be used a number of times a day and have to be kept airtight.

The handle is made by taking a 4-in. piece of ⅜-in. diameter brass condenser tubing and cutting a slot in one end on one side to enter the head of the cock plug. A tight piece of wood is driven in beyond where the end of the plug head comes. Then the end around the plug top is filled with solder. This makes a light soldered handle which never gets loose, as frequently happens with handles that are pinned or riveted on.

Sewickley, Pa. L. M. JOHNSON.

How a Damaged Crankshaft of a Center-Crank Engine Was Repaired

The crankpin of a center-crank engine came loose and a new one was ordered from a local machine shop with instructions to put the pin in on the following Sunday so as not to interfere with the normal operation of the plant. Two machinists were sent to put the new pin in on the following Sunday, as requested. Upon removing the old pin, they found that the new one was a few thousandths too large for the holes, and instead of dressing it down to the proper size they made the mistake of trying to force it to its place, with the result that both disks were cracked.

The next morning I was asked to look the engine over and see if it was possible to put it in shape to run, as it would require ten days to get a new shaft.

Upon examining the engine I saw that not only were both the disks cracked through the crankpin holes, but that they were standing at an angle of about 20 deg. to each other. After some consideration it was decided to shrink a steel band on each disk. As there was a clearance of $\frac{3}{16}$ in. between the disk and the engine bed, the bands were made $\frac{1}{2}$ in. thick and 5 in. wide, and to be a good shrink fit on the disks. A large clamp was used to draw the disks in line and parallel to each other.

The shaft was then put back into its bearings and rolled over to see if the clearance was all right. When the eccentrics, connecting rod and other parts had been assembled, the engine was started and it ran continuously until a new crankshaft arrived from the factory.

The time required to repair the damaged crankshaft and get the engine running was about six hours.

Pittsburg, Kan. W. J. LAPWORTH.

Locating Grounds on Lighting Circuits

Some time ago, when moving one of the circuits of a 110-volt lighting service, it was discovered that between one side of the line and the switch cabinet, which was grounded, 220 volts was obtained, and from the other side of the line to ground 110 volts existed. A survey of the plant showed that a similar condition existed at the other switch cabinets in the plant. After further investigations to locate the trouble, it was found that with the main switch open the same conditions existed on the line outside our plant.

The fault was traced by the power company's trouble men to another service about a mile away. As shown in the diagram, the ground was on the opposite outside

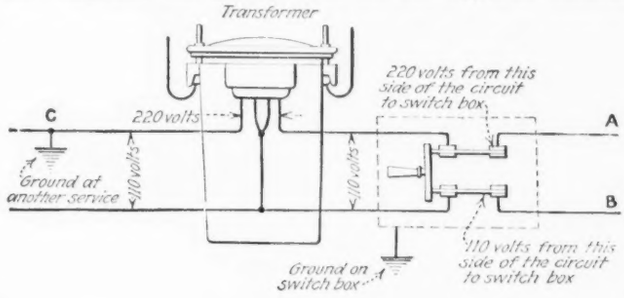


Diagram showing how line was grounded

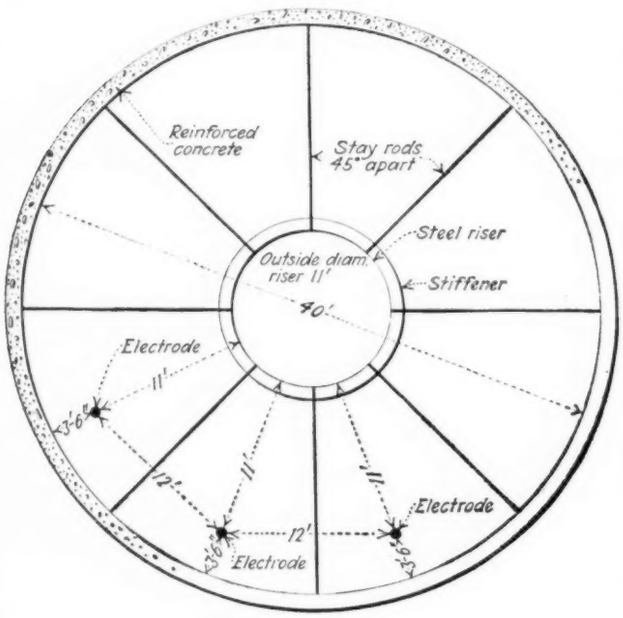
leg of the circuit, so that when I tested from the outside leg of the line in my plant, a circuit was completed for 220 volts, while a test from the middle leg of the system to ground showed 110 volts. How these voltages were obtained is indicated in the figure. A ground existed on line *C* outside the plant. The switch cabinets in our plant were permanently grounded. A test lamp connected from line *A* to the switch box completed a 220-volt circuit through the earth to line *C* outside the plant. In a similar manner a lamp connected from line *B* to the switch box completed a 110-volt circuit through the earth to line *C*.

Vancouver, B. C. R. MANLEY ORR.

How a Surge Tank Was Kept Free of Ice

In connection with a hydro-electric plant recently completed, a surge tank was constructed on the pressure tunnel a short distance above the power house. This surge tank is of the differential type, 40 ft. in diameter. A horizontal section is shown in the figure.

Three electrodes of 1-in. pipe were suspended in the outer chamber at the points indicated, and connected to a 15,000-volt three-phase line that ran past the surge tank. The water level varied 8 or 10 ft. in the surge tank owing to load conditions, the load being light during the night. The electrodes were suspended to a depth of approximately 6 ft. at times of light load, but at full load they were out of the water. The energy input at maximum immersion was 130 kw. As load



Cross-section through surge tank showing location of electrodes

came on the plant and the water level in the surge tank dropped, the energy input through the electrodes decreased practically in proportion. When the water level fell below the electrodes and the circuit was broken, there occurred only a small arc which was extinguished before it reached a length of more than two inches.

This feature of the heating arrangement worked out very well, as the plant was relieved automatically of the heating load at times of peak load on the system. At the time the electrodes were installed, there appeared to be a foot or more of broken ice in the surge tank. This was gradually melted and disappeared in about a week's time, and the surge tank remained free from ice for the remainder of the winter.

Some apprehension was felt that, owing to sudden dropping of load in the power house, the consequent disturbance in the surge tank would cause the electrodes to short-circuit or ground. However, no trouble of any kind was experienced, and the apparatus continued to function the entire winter without any attention. The daily input to the surge approximated 1,200 kilowatt-hours.

C. R. REID, Power House Supt.,
Shawinigan Water & Power Co.
Shawinigan Falls, Quebec.

Why the Hot-Water Storage Heater Failed

A short time ago, I was requested to investigate and make a report as to the cause of failure of a hot-water storage heater in a near-by institution.

The heater was a horizontal drum of approximately 500 gal. capacity, heated by an internal steam coil, the steam being controlled by a thermostatic valve. The drum was designed to withstand a pressure of 200 lb. and was fitted with dished heads. The dishing of the heads had been carelessly done, as the rounding of the heads at the flange, instead of forming an arc, presented an abrupt angle. A rupture ¼ in. wide and about 8 in. long, had occurred along the crest of this angle. As the rupture had been welded and the drum put back into service, it was impossible to determine the thickness of the metal, but it is reasonable to suppose that a flaw may have existed at the point of failure. The water pressure on the system was approximately 30 lb. The failure had occurred in the evening at about the time the steam is usually shut off; and all concerned, agreed that the water temperature in the drum was well below the boiling point—hence the inquiry as to the cause of the rupture.

The thermostatic steam valve was found to leak badly, but owing to the low temperature of the water when failure occurred, it is believed that the leaking thermostat had no material effect on the results.

The drum was equipped with a 1-in. spring-type pop valve, the outlet of which had been piped to a sump about ten feet away. This valve was found to be inoperative.

The cold-water feed to the drum was fitted with a check valve. This valve had been installed to prevent the hot water backing up into the cold-water lines, which had once resulted in the scalding of some plants which were irrigated from the cold-water line near the building. The investigation showed that an hour or so before the failure occurred, a large amount of hot water had been drawn off, after which little or none had been used up to the time of failure.

In the report, the following theory was advanced as to the cause: A large amount of hot water was drawn off, which was replaced by an equal quantity of cold. This caused the temperature of the drum to drop to practically cold-water temperature. As the temperature was brought up by the steam coil, no hot water was drawn off. The hot-water valves on all fixtures in the building were in good condition, thus preventing any leaks. The check valve in the cold-water feed to the drum was also in good condition. The pop valve was stuck shut, consequently a considerable pressure was developed by the expansion of the water as it became heated, resulting in the rupture which occurred at a point in the drum which may have contained a flaw due to faulty construction.

It was recommended that the check valve in the cold-water feed line be removed; that the pop valve be repaired and the pipe removed from its discharge opening, and that the thermostat control valve be repaired or replaced with one that would control the water temperature properly. As this had been the third failure of a like nature to occur, steps were immediately taken to comply with the recommendations and no further trouble is anticipated.

A. C. MCHUGH, Chief Engineer,
Norwalk, Calif. Norwalk State Hospital.

Comments from Readers

Making a Pulley on Short Order

Referring to the letter by A. B. Newell in the April 19 issue on "Making a Pulley on Short Order," I am usually opposed to home-made articles of this kind, as they almost invariably cost much more than factory-made products, and when finished they are not so good. This particular pulley, it appears to me, would be rather heavy and costly. Besides, Woodbury, N. J., is not far from Camden and Philadelphia. If this incident occurred at Woodbury, it seems to me that a new standard pulley could have been obtained from either of the cities named more quickly and at lower cost than by making the pulley illustrated, or why not turn a temporary pulley out of wood? M. M. GOOCH.

Atlantic Highlands, N. J.

Dollar Efficiency Versus Technical Excellence

After being associated with steam and water gages, safety valves, Corliss engines and turbines for over thirty years, it certainly is a pleasure to have a chance to read a new line, and to get the other fellow's idea on something else. I refer to Mr. Reynolds' sketch, "Dollar Efficiency Versus Technical Excellence," on page 754, May 17 issue.

As an engineer and machinist apprentice, I was taught to shun the technical man. My instructor impressed this so thoroughly upon me that it was several years before I could overcome my suspicions sufficiently to inquire into the status of the aforementioned gentleman. To add to my instructor's views, a few cases of bad design and poor engineering could be laid directly to the college graduate.

But after perhaps ten years of this feeling, I, for some unknown reason experienced a change of heart, as it were, and thought that maybe, after all, there were some technical graduates who knew almost as much as myself. Another five years and I was positive of the fact. That is what association will do for some men. The partly collapsed interior of the conning tower, or head, may be slightly inflated (it is dangerous to carry it too far) if proper associations are maintained.

It became my privilege and pleasure to get acquainted with technical men. I found them no different from myself except in one thing—*they knew, where I guessed.* So far as fifteen years of experience was concerned, I had learned only elementary stuff as compared to what they knew. And then it occurred to me that the reason for my instructor's early training regarding technical men was—jealousy!

After this prelude, I will say a few words on dam building and technical estimates. When a job is underestimated by a new college graduate, the lack of practical experience in the field is probably the reason. But when a technical graduate of years of experience falls down time after time in estimating, something is wrong.

The young man just out of college does not know, through lack of experience, that machinery in general will fall down at times, and that the human element is worse than the machinery. But the man with twenty years behind him in this work knows it.

He knows that things work according to Hoyle or Kent only once or twice in a lifetime. He knows that a 24-in. wall is wasteful where a 16-in. one will suffice. He knows surfacing concrete to make it look good and then covering it under fifteen feet of filling costs money. He knows that imported rock for ballast is no better than the rock he is standing on and he knows—a whole lot that I wish I knew.

Along with the gage glass, safety valves, Corliss engines and turbines, I have designed and built a couple of dams, which cost *less* than the estimates, therefore I maintain that the technical man of experience has no business to fall down on estimates if he is allowed to supervise the project. C. W. PETERS.

New York City.

Certainly there can be but one answer to the questions given in the last paragraph of C. W. Reynolds interesting letter in the May 17 issue, namely, that the engineer should shoulder the responsibility. But concerning the rest of that comment, in which undoubtedly the moral—that we should not underestimate costs—is extended, I wonder about several points.

If a good engineer is the fellow who can do with one dollar what anybody can do with two (from Mr. Reynolds' comment) then the engineer of Mr. Reynolds' narrative must have been a poor one, which is evidently what the bankers backing the project thought. Had this engineer had more training or experience, he probably would not have underestimated so far, and conversely, had he not underestimated so far, it might have been because he was more experienced or perhaps was a better engineer. In other words, the really good engineer should be able to estimate a cost very closely.

Continuing along this line of reasoning, we find, by transposing the moral of Mr. Reynolds' narrative, that it is suggested we strive to be adept and efficient engineers.

In striving for this goal certainly we are dependent upon experience, which to me seems impossible without some underestimating for which engineers are noted.

As Mr. Reynolds has offered no alternative and as I am sure many of us cannot estimate correctly every time, I wonder if it is not better to underestimate deliberately, when it is felt that it is impossible to state a figure exactly, than it is to overestimate, the only other choice when a single figure is required. If you are so unfortunate as to lose your position or sustain financial loss, you have gained experience that might never have presented itself had you overestimated, for your figure on paper means considerable to the business man, who, after all, is usually disposed to tolerate some additional financing. He is used to it.

Arlington, N. J. RAYMOND L. DREW.

What Causes the Fusible Plug to Corrode?

In two water-tube boilers installed in our plant about three years ago, the inside-type fusible plugs with which the boilers are fitted corrode rather rapidly and have to be replaced. The soft metal becomes honeycombed and blows out in about two months; also the brass bodies show signs of corrosion down to the shell of the boiler. In two old boilers which have been in fifteen years, there is no sign of this trouble.

The water used in the boilers is largely returns from the heating system, which come back at an average temperature of 160 deg. The makeup water is Zeolite treated, and we are careful to wash out the salt solution to the point recommended by the manufacturer. The steam pressure carried is 150 lb. I should appreciate some practical suggestions from readers of *Power* as to the probable cause of this trouble and how to overcome it.

Springfield, Ohio. C. W. HOWARD.

Increase in Cylinder-Oil Consumption Due to Boiler Compound Entrained in Steam

In answer to W. E. Foley's inquiry in the April 26 issue on the "Increase in Cylinder-Oil Consumption Due to Boiler Compound Entrained in Steam," I believe that much of this compound trouble lies in feeding more compound than is necessary, thus giving an excess amount of silica, also carrying too high a water level and not properly blowing down the boiler.

In the case of high water level some of this silica is carried out with the water and steam. This also happens when too great a degree of saturation is reached. In such a case the silica will find its way to the engine cylinder and cause the piston to groan. The immediate remedy is to blow the boiler down several times.

When blowing down a boiler at the end of each shift, it should be done from the water level generally carried, as a heavier concentration is blown out. It is not a good policy to fill the boiler to the top of the gage glass first and then open the blowoff. I have known the silica in some compounds actually to bake on the tube. Upon changing to a different compound, the silica was released and the water became so dense with it that it was necessary to blow the boiler down several times. We then managed to run until the boiler could be cut out of service.

With a clean boiler, just enough compound at scheduled intervals, scheduled blowoff and not too high a water level, there should be no trouble. A. MAIER.

Monterey, Calif.

Bonus System for Power Plants

Relative to inquiries regarding the bonus system for power plants, the best bonus I know of is the union scale of wages.

As everyone who has ever been affiliated with organized labor knows, the union scale is not regarded by labor as the maximum, but the minimum scale for which a man should work.

If you pay the scale for your locality, for eight hours, time and one-half for overtime, you can generally get good men. If a man is worth more, give him more than the scale. You'll get efficiency, because if the men you have don't give it, you can easily get others who will; a plant where pay and working conditions are as good as any in town can always get men and pick the best.

I happen to be a member of the A.S.M.E., but I am not in any way affiliated with organized labor. Mechanical engineers are not "organized"; perhaps if they were, some would be better off. It has been my experience, however, that generally the most capable and reliable men in the various trades are affiliated with organized labor.

In this locality I have never known of an instance in the last ten years where the engineers have ever violated an agreement with an employer, and they have always been fair and reasonable to do business with. Pay your engineers and treat them with the same consideration as your plumbers and steamfitters demand and you won't have any bonus problem.

Rochester, N. Y. J. L. WADSWORTH.

A bonus system desirable for the power plant would be such as encouraged punctual and steady attendance among the staff, and also promoted growth. Considerable overhead is added in the course of a year owing to the necessity of seeking and developing new men. No sooner does an engineer get a firm foothold with the power plant than something intervenes; he leaves, and a new man must be sought. This makes for lack of solidity; for there is no more desirable feature among the staff than steady, years-long service, representing experience, loyalty and enthusiasm. Has not, then, the bonus system a worthy place here?

But what manner of bonus system should be evolved? What will appeal to the engineering staff and at the same time make the possibility of a given number of months' service almost a certainty? What will discourage tardiness and bring about rigid recognition of the company time clock? Just what bonus system should be adopted so that wholehearted co-operation will result?

For consideration there is suggested one that should appeal to all really eager to do their best by the power plant. There should be offered a set of payments that immediately will encourage punctuality, discourage absenteeism and also "floaters." Get the staff together and discuss the project. Let it be known, for instance, that the plant is going to offer two kinds of payments, representing class A and class B. Class A, of course, should stand out as a worthy goal. An engineer, for example, would be in class A provided his time-cards indicated consistent punctuality and attendance. Enough leeway, however, ought to be afforded for occasional, unavoidable tardiness. To make for accurate recording it is obligatory that all must ring in and ring out time cards, at least twice daily—mornings and at the close of the day. Three or four times would, of course, insure still closer and accurate tab on the men's time.

Should an engineer come late and his tardiness be of excusable nature, it thus can be signified on the time card, by the chief. Repeated tardiness, naturally, would point a finger at the laggard, and the chief usually could tell who of his staff were really eager to get in on time. So, little difficulty should be encountered here.

Class A would entitle a man to a lump sum of $200, it being the power plant's object now to insure services for an entire year, at the end of which the earned sum could be paid. The power plant would know just which of the men are striving to attain commendable punctuality and attendance, the $200 being a suitable incentive.

Class B would entitle a man to monthly payments, representing for the year a total of $90. Such of the staff would come into this class whose time cards showed reasonable tardiness, comprising, let us say, for an entire week, not more than fifteen minutes. Almost any man will come late sometimes; the main object, after all, is to put the damper on that man who is habitually tardy. To induce still greater punctuality and steadiness among the staff, it would be worth while to set forth in the plant's announcement of this bonus system that monthly payments are optional, but that the privilege would entitle a man only to class B payments. Class B, thus, would represent those of the staff whose time cards signified not the best of punctuality, within the fifteen minutes weekly allowance, and those individuals desiring monthly payments, in other words $7.50, this sum, however, also having to be earned.

There is this further stipulation to be included in the bonus system—an absentee must show cause. Perhaps he has business to attend to. He may be sick for a day. All this is excusable, of course; nevertheless, a check on the fact must be maintained, so as to discourage the habitual absentee and so accurate records can be maintained. Continued illness would call for a physician's certificate, and all tardiness and absence of excusable character would in nowise affect a man's standing or debar him from enjoying the higher class rating.

In conjunction with the announcement of such a system notices of the rules and conditions should be posted in conspicuous places. Striking on the part of individuals, and similar infractions, would affect, let us say, a man's standing and eliminate him from the participation in awards.

A bonus system of this kind would solve many of the power plant's problems. Engineers would think twice before leaving for other places; delinquent tardiness would almost entirely be discouraged; there would be steady attendance; the power plant would at least in the case of class A participants, be assured of an engineer's service for an entire year. And the considerable trouble, worry, loss of time and money, and set-backs resulting owing to irregular attendance, would automatically be eliminated. Instead, the plant would be represented by a loyal and hard-working staff, growing with the company.

FRANK V. FAULHABER.

Brooklyn, N. Y.

Outwitting the Smoke Inspector

In the April 12 and the May 17 issues, respectively, Richard Parrott and E. R. Webber bring up a few points concerning my article in the March 22 issue on steam jets installed in Murphy furnaces.

The title "Outwitting the Smoke Inspector," which was placed at the head of the article by the publishers, may have caused a little resentment in some quarters, and I wish to say at the outset that I have the highest esteem for the personnel of the Cincinnati Smoke Department. Every member of this department has been a personal friend of mine for the last fifteen years, and the article was not intended as a slur but rather for constructive criticism.

Mr. Parrott says that every imaginable kind of steam jet has been inflicted upon the furnace and that patents have been taken out on all styles of nozzles and devices. I fully agree with him on these points. Fifteen years ago I contributed an article to the *National Engineer* on an automatic device I had attached to a steam jet which entered through the front wall of the furnace.

I do not claim beneficial results for all furnaces by using steam jets, but I still maintain the benefits I outlined in the article for the particular type of furnace referred to.

Mr. Parrott says that if I were to measure the steam used by the jets, I would not be quite so enthusiastic about the arrangement. This has been done and the jets consume 350 to 500 lb. of steam per hour, but when the jets are turned off the steam output of the boiler, as indicated by the flow meter, drops back about 2,500 lb. and the moment the jets are again turned on the steam flow increases 2,500 lb. Mr. Parrott also says that the effect is mechanical and not chemical. But in my opinion the increase in efficiency is due largely to a chemical effect. Referring to pages 6 and 7 of "Finding and Stopping Waste in Modern Boiler Rooms," second revised edition, Vol. 2, published by the Cochrane Corp., the charts on page 6 show anthracite with 95.6 per cent fixed carbon and 1.2 per cent volatile having 14,440 B.t.u., and a high-rank bituminous coal of 64.6 per cent fixed carbon and 32.2 per cent volatile having 15,160 B.t.u. If only fixed carbon had heating value, the anthracite coal would furnish 14,440 B.t.u. and the high-rank bituminous only 9,750 B.t.u., so the balance of 5,410 B.t.u. (which makes 15,160) is obtained from the volatile matter, a great part of which consists of hydrogen. Also, the first paragraph on page 7 states that several of the groups shown have a higher heating value than pure carbon (14,600 B.t.u. per lb.) due to the presence of hydrocarbons in the volatile matter, the combustion of hydrogen developing 62,000 B.t.u. per pound.

Quoting from my previous article with a few additions: Formerly, when observing the fires with dark glasses it was seen that the gases left the fuel bed at the upper portion of the inclined grates and immediately took a direction toward the boiler tubes (vertical water-tube boilers with dutch ovens). Consequently a considerable portion of the volatile matter rich in heat units escaped. But with the jets in use a well defined turbulent action can be seen. The volatile matter is driven down and whirled around in the incandescent heat zone and a proper mixing of the gases takes place before passing on to the combustion space. The best explanation I can give is that we now secure more heat from the hydrogen in the volatile matter than formerly.

Mr. Parrott also referred to the sulphur content of the fuel and the corrosive effect that steam in connection with sulphur may have. However, as these furnaces are operated normally at high temperature, and the flue gases generally between 600 to 700 deg. with boiler operating normally around 175 per cent of rating, there is little likelihood of any trouble from this source; in fact, we have not noticed any more corrosion than formerly.

I will, however, admit one of Mr. Parrott's points as well taken, that the steam admitted must be heated up to furnace temperature and carried up the stack—but I will say that the efficiencies noted far outweigh this one deficiency. This also applies to Mr. Webber's remarks on firing wet coal; the moisture in the coal must be heated to furnace temperature and robs the furnace or boiler of considerable heat.

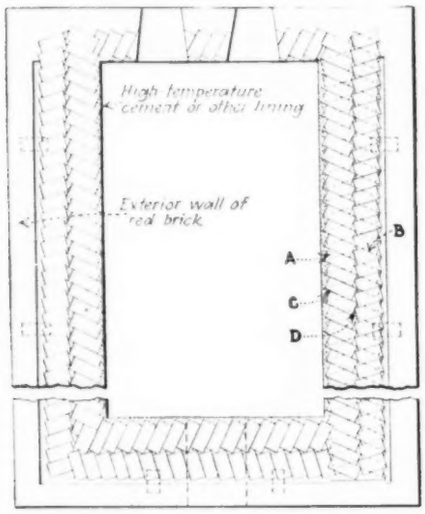
Cincinnati, Ohio. A. A. FETTE.

New Plant Construction

Bernhard Improved Furnace Wall Construction

A type of furnace construction for use with boilers or Dutch ovens in which the bricks are so arranged as to provide a suitable gripping face for holding a high-temperature cement or other monolithic lining has been developed by Louis Bernhard, 141 Milk St., Boston, Mass.

Referring to the illustration, it will be seen that the bricks in one course are reversely arranged with relation to the corresponding bricks of an adjacent course. For instance, the firebricks *A* and *B* are laid parallel, but



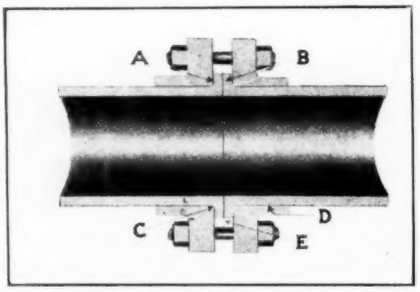
Plan of furnace with bricks set diagonally to present gripping face for lining

their long faces are at an angle to the chamber and also to one another, so that they form pockets such as *C* and *D*. They are also at the opposite angle to the bricks in the row directly below. Therefore, it will be apparent that the inner surface of the wall will have numerous angular-shaped pockets which present a substantial gripping area for the furnace lining.

Improved NAVCO Pipe Joint for High Pressures

A type of pipe joint designed especially for high steam pressures and temperatures is being manufactured by the National Valve & Manufacturing Co., Pittsburgh. It includes many of the features embodied in the well-known Van Stone joint in addition to recent improvements that make it adaptable to the higher pressures.

The outstanding feature of this joint is the back facing of the lap at *A* to insure perfect alignment. After facing both back and front, a lap *B* of full pipe thickness is maintained. The radius *C* of the flange and the lap-fillet radius are concentric. Only a minimum clearance is allowed between



Navco Nos. 4, 6, and 9 pipe joint

the pipe and the flange as at *D*, just enough to permit the moving of the flange on the pipe. The complete joint is annealed to relieve any strain that may have set up during the course of manufacture. A self-centering gasket *E* is used in making up the joint.

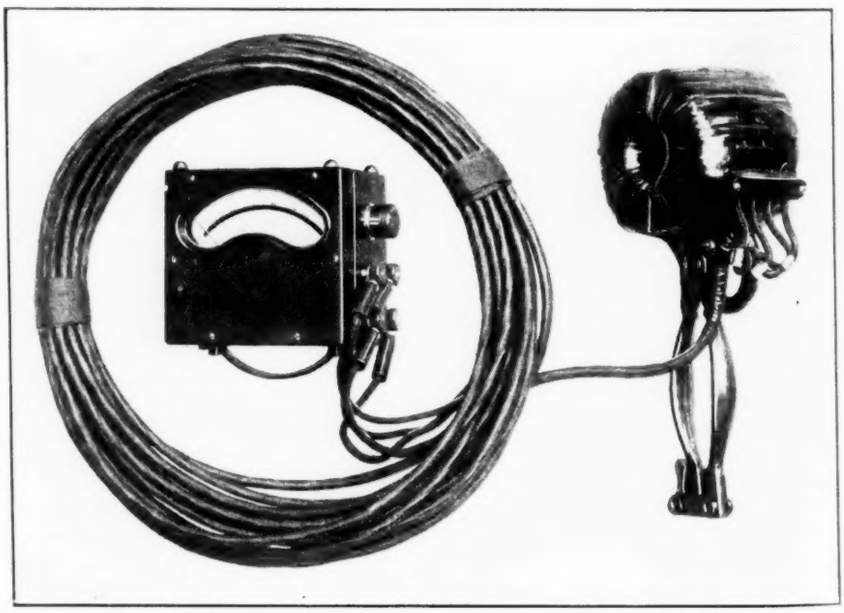
A New Portable Current-Testing Set

A split-core current-measuring set that is especially useful in determining the load on feeders or distribution lines has been introduced by the General Electric Company. The set is intended for use in determining the alternating-current flowing in a conductor without opening the line to insert an ammeter or a current transformer. Each set consists of a transformer with a hinged magnetic circuit as shown at the right in the figure; leads; and one or more ammeters. It can be used to advantage when the accuracy required is of the order obtained with self-contained ammeters or portable current transformers and ammeters.

A distinctive feature of the set is the ease with which the transformer can be clamped about the conductor. In the case of overhead lines the transformer can be clamped from below, thus avoiding the necessity of reaching over high-voltage lines. Flexible multi-conductor leads 50 ft. long are supplied with each set. Two sizes of transformers are supplied, one having a conductor opening 1¼ in. and the other 2¼ in. in diameter, for current ratings from 75 to 500 amperes.

A small size indicating ammeter is furnished. It has a cylindrical switch by means of which the various ratings of the set can be readily obtained without the necessity of changing connections at either the transformer or the ammeter. Each indicating instrument is calibrated with the transformer with which it is to be used, so the scale reads directly in primary amperes.

The recording instrument listed as standard with the sets is a portable round-pattern instrument with an 8-in. diameter chart and a one-day clock. The chart normally furnished makes one revolution in 24 hours, but other chart speeds such as one revolution in 1, 6 or 12 hours can be furnished. Similar recording instruments with eight-day clocks or with Warren motor-driven clocks and with different charts can be supplied.

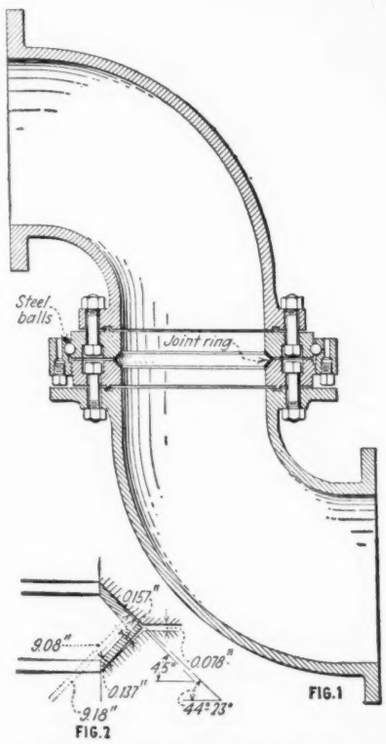


Portable current transformer and ammeter

Luc-Denis Expansion Joint

The Luc-Denis expansion joint reproduced herewith from *Engineering* is designed to provide pipe expansion by a rotary movement of a pair of flanges which are coupled together, the pipes joining the links of a lazy-tongs arrangement.

The joint consists essentially of two bends, to one flange of each of which is rigidly bolted a thick facing ring with a metal-to-metal joint. The bolts only indirectly play a part in holding the two flanges and their facing rings together. This coupling is directly effected by an outer ring which covers the joint between the two facing rings and is screwed to one of them, while the connection is made with the other by means of a ring of steel balls in the position shown in the illustration. It will thus be clear that the pressure



Figs. 1 and 2—Section of joint and detail of packing

tending to force the joint apart is opposed by the shearing strength of the balls on one edge of one facing ring and the resistance to the stripping of the thread on the edge of the other.

When the outer ring is correctly placed, the setscrews with which it is fitted are adjusted against an extension on the lower flange. The ring is thus locked in position. The balls are loaded into the race through a single hole drilled on the vertical joint between the facing rings and the outer ring. When all are in position, the halves of the hole are widely separated.

The means adopted for keeping the joint steamtight is shown in Fig. 2. Each of the facing rings is beveled on the inside with a relatively large spherical radius. In the groove thus formed lies a thin V-shaped ring which is kept tight against the sides of the groove by the pressure in the pipe.

Caldwell Speed Reducers

As indicated in the accompanying illustrations, the Caldwell speed reducer, designed in two types for general industrial uses and screw-conveyor service, is a self-contained unit combining two separate drives—a silent chain drive from the high-speed shaft and a cut spur-gear drive to the low-speed shaft, with the driving motor mounted

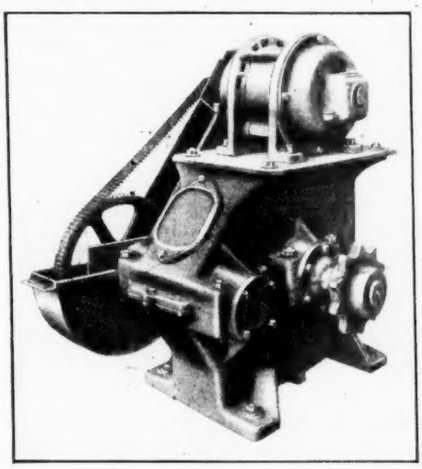


Fig. 1—Type A Caldwell speed reducer for general industrial use

on an adjustable bedplate on top of the housing. Being inclosed in dustproof housings, both chain and gears are operated in a bath of oil. Tapered roller bearings, carried in cartridge mountings, support the shafts.

Type A, shown in Fig. 1, is made in sizes to furnish ratios from 7 to 1 up to 40 to 1 and for motors ranging from 5 to 15 hp. A convenience to the user

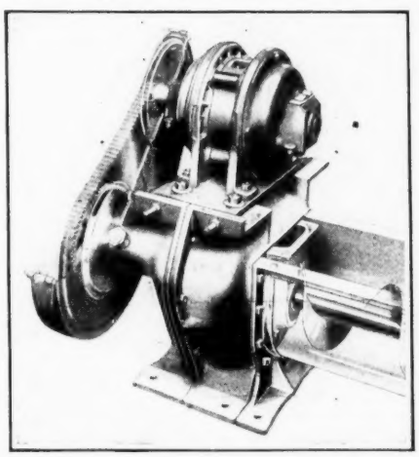


Fig. 2—Type B speed reducer designed for screw-conveyor drive

is the ease with which speed ratios can be changed by substituting different sizes of motor pinion or driven wheel, owing to the fact that the chain drives for the reducers were taken from the standard sizes of chains and wheels carried in stock.

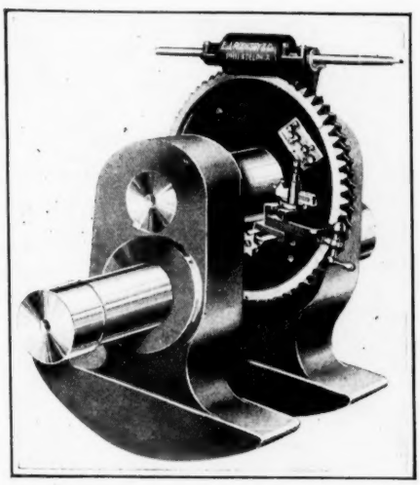
Type B speed reducer, designed especially for driving screw conveyors, is shown in Fig. 2. Part of the housing of this reducer forms the box-end of the conveyor, a dust seal being provided to keep the dust from working into the bearings. Except that the bearings are of the bronze-bushed self-oiling type and that the housing is split vertically, the reducer in general is the same as Type A. Ratios of 7 to 1 up to 30 to 1 are available for conveyors running from 9 to 20 in. and motors ranging in capacity from 3 to 20 hp.

These speed reducers were developed by the H. W. Caldwell & Son Co., a subsidiary of the Link-Belt Co., of Chicago.

Rooksby Portable Crankpin Turning Machine

An improved portable crankpin turning machine for truing up worn center crankpins of steam, gas or Diesel engines has recently been brought out by E. J. Rooksby & Co., 1042 Ridge Ave., Philadelphia, Pa.

The illustration shows the front view of the machine, which is composed essentially of a stationary and revolving disk. The revolving disk is supported in the stationary disk by a keeper ring which provides a substantial journal bearing as well as the thrust bearing. The stationary disk



Pin-turning machine in position

is secured to the inside face of the crank cheek by adjusting screws and the studs and clamps.

The revolving disk is driven by a worm gear of ratio suitable for either air or electric motor and carries a substantial arm with a slide block and cross-slide having tool post and turning tool, giving a feed both ways on the pin provided by a star feed. The cross-slide, for setting to the correct diameter, is similar to the slide block of a lathe.

Both of the disks and the keeper ring are split and fitted with tongue-and-groove joints so that they may be readily assembled on the crankpin, at the same time keeping these parts of the machine perfectly true.

The machine is bolted to the finished inside cheek of the crank, which sets it square with the pin. Provision is made for setting to the original center by a supporting crossbar with a center and sleeve having screw adjustment similar to the tailstock of a lathe.

The machine has a capacity to turn crankpins from 8 to 11½ in. in diameter and from 7½ to 9 in. long.

N. E. L. A. at Atlantic City

Secretary Davis Outlines War Department's Plan for Mobilizing Power of Country. William Green Discusses Labor's Attitude Toward Power in Industry. Engineering Section Reports on Progress in Field

THE Fiftieth Convention of the National Electric Light Association at Atlantic City last week was up to the usual standard in attendance and fullness of program, and the exhibits on the Million Dollar Pier exceeded those of any previous year, there being 195 as compared with 184 last year and 138 in 1925.

President R. F. Pack, in his opening address, reviewed some talks and predictions expressed at the first convention of the Association, held in Chicago in 1885, and compared present-day advances with the state of the industry at that time. One speaker at the first meeting had expressed the opinion that it would in time be possible to supply power to motors of from 1 to 5 hp. Another asked whether it was possible to run two street cars in opposite directions at the same time; while the Mayor of Chicago declared that, as the protector of 600,000 people, he did not want "death dashing like a horrid monster through the streets."

The half-mile transmission lines of 1885 were approximately 500 volts as compared with 250 to 300 miles and 220,000 volts at present, and the 200-kw. dynamo has given place to one of 208,000 kw. Moreover, it then took 10 lb. of coal to produce a kilowatt-hour as compared with an average of 1.91 lb. or 0.9 lb. in our best stations of today. Mr. Pack stated further that privately owned central stations of the United States in 1924 generated 48.25 per cent of all the kilowatt-hours produced throughout the civilized world, and that from 1909 to 1923 the power required to operate industry had increased 34 per cent per wage earner.

Outlines Plan To Conscript Power in Time of War

The government's plans for conscripting power in time of war was outlined in an address by Secretary of War Davis at the General Session on Wednesday morning. The plan is based on the five following principles:

1. The government should not take over any plant or power system unless necessary to insure the efficient prosecution of the war.

2. No additional control should be exercised in regions where power is adequate for present and immediate future needs, both civil and military.

3. When shortage of power for essential needs exists or is threatened, the government should take over the entire output of the plant, or plants, in the locality and apportion the power output to users in the best interests of the United States. This action should set aside all existing contracts for the supply of power with which such action conflicts.

4. If the preceding methods fail to obtain sufficient amounts of power, the government should undertake actual operation of such plant or plants.

5. The existing organizations of any companies taken over should be utilized in their operation, in order to make full use of the experience, training and skill of their personnel.

The plan calls for the selection by the President of an executive assistant to be known as the Emergency Power Director, who would be responsible for the effective utilization of the power facilities of the country.

The emergency power director would be assisted by an executive committee the majority of the members of which would be nominated by the National Electric Light Association, and approved by the emergency power director. These men would serve in a civilian or military capacity.

All revenues from operation during federal control would belong to the United States, and all expenses of operating during federal control would be paid by the United States. Compensation to be paid the company would be the sum equivalent to the average net operating income of that particular company during the preceding three fiscal years, except that if exceptional or abnormal conditions were found by the President to exist during all or a substantial portion of such period of three years, which would justify a larger or smaller compensation as might be found to be just and equitable.

Electric Power as a Boom to Labor

In a notable address on the "Relation of the Electric Light and Power Industry to Labor," William Green, president of the American Federation of Labor acknowledged the part played by electric power in advancing the economic position of the worker and urged a spirit of mutual understanding between the management and the workers. Mr. Green said in part:

It is in the field of industry and labor that electric light and power has made its most marked advances and extended its service to the greatest degree. The lives and welfare of the great mass of working people associated with industry have been vitally affected through the introduction and use of electricity. There is a close relationship between the electric light and power industry and labor. It is a relationship which affects wages, productivity and efficiency. The production of electrical energy has practically doubled during each five years since 1900.

The use of machinery in industry antedated the use of electricity. A great change was brought about through the introduction and installation of machinery of various kinds in practically all lines. During this period of important changes capital, labor and machinery were regarded as the three factors essential to production.

With the advent of electric power another factor was added. This factor increased the value of machinery many fold and the productivity and efficiency of the individual worker was increased in ratio to the increase in value. Electric power has proved to be a revolutionary factor because, through its adaptability and its general use, it has been proved that the wages of labor can be substantially increased while the cost of the manufactured article is materially reduced. A study of these economic facts caused the American Federation of Labor to make the following declaration regarding wages:

"We hold that the best interests of wage earners, as well as the whole social group, are served by increasing production in quality as well as quantity and by high wage standards which assure sustained purchasing power to the workers and, therefore, higher national standards for the environment in which they live and the means to enjoy cultured opportunities."

The initiative of those who ventured in the field of industry has been rewarded by the success of their endeavors. They have been fortunate in that they have been permitted to carry on their business in a land which guaranteed to them the right to own and possess property and to enjoy all the benefits which come from private undertaking and private enterprises.

Industrial freedom is as essential to human happiness and human welfare as political freedom. Let us hope that our nation will always remain free from governmental, autocratic and dictatorial control of its industries and its workers.

Successful as we have been it must be apparent to all students of human relations and economic development that the future success of industrial effort depends upon the creation and maintenance of a co-operative relationship between the human forces connected with industry. There must be teamwork influenced and inspired by a spirit of fair play and justice.

The highest and best interests of all can be served through co-operation and understanding. I sincerely hope that

the wage earners and the employers and management associated with the electric power industry will establish a happy reciprocal relationship based upon a recognition of their common interest and common welfare. Through the adoption of such a plan agencies can be established through which they may solve their economic and industrial problems and further the uninterrupted operation of their plants in the interest of the public good and the public welfare.

Engineering Section Reports on Trends in Practice

In the absence of A. D. Bailey, the Prime Movers report was presented by E. J. Ricketts. This reviewed the trend toward high steam pressures and temperatures and recalled that experience with 1,200 to 1,400 lb. installations had shown many of the precautionary measures taken had proven unnecessary. Considerable trouble is being experienced in many plants with defective steel castings in valves and fittings, due to poor material, improper foundry practice and faulty design, which could be minimized by proper specifications and purchasing methods.

In condenser practice there is a trend toward reduction in surface because of improved water rates and bleeding, and a demand for arrangement of tubes so as to provide easier access for steam into the inner parts of the condenser. Exploration tests at Delaware, Hudson Avenue and Hell Gate Stations, made to determine the extent of activity of the various parts of the condenser, show that considerable benefit would result from the removal of inactive tubes.

The work of the Prime Movers Committee for the year included the collection of operating data on water-cooled walls, a study of different methods of increasing superheat, the effectiveness of slagging screens, stratification and disassociation of steam in superheaters. Developments in stoker-fired furnaces point toward the use of preheated air up to 500 deg.

Mr. Ricketts concluded with the hope that ways and means might be found to put scientific knowledge on a production basis.

Hydraulic Power

On behalf of the Hydraulic Power Committee, H. L. Doolittle reviewed some of the problems and improvements in hydro-practice during the year. There are now being constructed double overhung wheels of 56,000 hp. to operate under 2,200 ft. head. These are the largest impulse units to date. The 54,000-hp. reaction turbines which will operate under 89 ft. head at Conowingo establish a new record from the standpoint of physical dimensions.

Other units are being built to operate under 2,545 ft. which will be the highest head in the United States. This has introduced some difficulties in penstock design. A penstock is now being built, a portion of which is made of seamless steel forgings 66 in. diameter, 3 in. thick and 30 ft. long. Moreover, it has been found economical to use large quantities of banded pipe made in Germany.

In the matter of efficiencies, the Muscle Shoals units have attained 93.1 per cent, and a new type of runner tested at Holyoke has shown 93.7 per cent.

While the water-lubricated lignum vitae guide bearing continues to be used extensively on vertical units, the water-lubricated rubber bearing is giving satisfaction and receiving wide attention. For the higher heads oil-lubricated babbitted bearings are necessary. Individual bearing lubrication seems to be favored over the central system. Considerable trouble has been experienced with oil from the guide bearings being drawn into the generator with the cooling air, as a result of which a new type of bearing has been designed.

Mr. Doolittle concluded by commenting on the growing use of steam power in the far West, pointing out that large production of oil and natural gas, together with the proximity of vast quantities of coal in neighboring states, and ability to locate near load centers, had made the steam plant a formidable competitor of the hydro-electric station.

An Engineer's Viewpoint of Managing Industrial Power*

By Henry F. Scott†

THERE is every reason to consider the power plant as a separate concern or a subsidiary company within the factory, responsible for supplying generated or purchased power, light, heat, and possibly other services, together with the transmission and application of this service.

The management should demand the same executive ability from the head of this department as from the head of any manufacturing department. The power house should be operated with at least the same degree of safety and cleanliness, and should maintain the same standards of performance that exist in the manufacturing departments. Often the returns on investments in manufacturing departments are greater than those made in the power house. Consequently, they are not made, though power-house investments could be made from which returns would be sufficient to warrant making improvements. The need of them can always be determined by comparing the power-plant cost of operation with past performance, with estimated cost of purchased power and heating plant, with a more modern plant, and with outside plants. For this reason a complete system of accounting should be set up, showing quantities and costs of raw materials used and the cost of manufacturing and distributing the product.

In most industrial plants engineering work is an important factor, but the responsibility and results are difficult to measure. In the power plant there is every opportunity for the measure of responsibility and performance, and the management has every reason to expect continuity of service and economy in production of power, light and heat.

The important consideration in the development of industrial power is service to the manufacturing departments. Meters and recording instruments help to improve such service, especially outside of regular working hours when there are special conditions concerning processes that extend over that period.

Economic operation of the power plant is the conversion into steam of the energy contained in fuel for heating, or for the generation of power, with the minimum loss of heat units. If the use of heat did not extend beyond the power house, the measure of economy would be comparatively simple, but in the industrial plant it is complicated by the use that is made of the steam at high or low pressures and by the wastes that occur, either from necessity or by improper control or improper methods of distribution and application. Where steam is used for process and heating, serious losses may occur in the plant on account of hot water going to waste. The prevention of such losses may be brought about by more careful control in the manufacturing departments and by improvements in equipment, but the management should assist in obtaining co-operation from the manufacturing departments.

Power-plant costs can be very convincing if the accounts are so distributed in the manufacturing plant that the power house appears as an independent unit. The charges for fuel, payroll, supplies, maintenance, fixed charges and administration can easily be distributed to the power plant and become the basis of the cost for power, light and heat delivered. Where only one product is manufactured, the cost of operation of the power plant is frequently figured against the unit of output, but this does not eliminate the necessity of arriving at a true cost of steam and power. The management should be supplied with concise figures concerning units with which they are familiar, such as cost per thousand pounds of steam, and the cost per kilowatt-hour, together with the reason for and discrepancy between these costs and the cost that might be obtained under ideal conditions.

It is the responsibility of the power-plant engineer to watch the changing conditions as the capacity of the plant is approached, and the management should be given sufficient warning in order to be prepared to consider additional equipment when necessary.

The determination of the amount of power to provide should be influenced more by the management than by any outside authority. The selection of equipment should, however, as far as possible, be made with the approval of the power-plant engineer, regardless of the fact that it may finally be left to the judgment of the engineering department or to consulting engineers.

The realization on the part of the management that these engineering problems require considerable combined technical ability and experience should lead to the careful selection of plant engineers. With the constantly increasing responsibilities this work will take its proper standing in relation to other departments in industry.

*Abstract from "Management of Industrial Power—Engineer's Viewpoint," presented at A.S.M.E. spring meeting.

†Plant Engineer Dennison Manufacturing Co.

News in the Field of Power

American Boiler Manufacturers Review Industry and Plan Expansion

Convention in Indiana Hears of Over-Capacity in Boiler-Making Equipment and Needed Commercial Growth—Studies Central Station Competition

MEMBERS of the American Boiler Manufacturers' Association held their thirty-ninth annual convention at French Lick, Ind., from May 30 to June 1.

In calling the meeting to order George W. Bach, president, used a gavel made of a short stout and a long slim rivet, which had been presented by D. J. Champion of the Champion Rivet Co. In his opening address President Bach stressed the need of attention by the association to the commercial side of the boiler industry, pointing out that there is a large over-capacity in boiler-making equipment, and that trade development work should be carried on for the extension of present markets and the opening up of new outlets for boilers.

Boiler Business not Growing Rapidly

Compilations of the Bureau of the Census and Industrial Statistics, based upon reports from members of the association, indicate that the boiler business has held its own but has not grown with general business proportionate to the population, because of the higher rates at which boilers are driven and the more economical use that is made of the steam produced. Remarkable growth in the use of steel boilers for heating service was reported. The average size of the water-tube boiler for power purposes is around 5,000 sq.ft., which fact shows that the industrial power field is still the largest factor in our industry. There is a decline in the numbers and capacity of h.r.t. and vertical fire-tube boilers, as between 1919 and 1925, which indicates that the h.r.t.'s are being replaced with the type of boilers in the heating field and that the verticals are being set aside by internal combustion engines in hoisting machinery and shovel service.

In dealing with the commercial side of the business Mr. Bach referred favorably to the commercial arbitration which has now been legalized in New York, New Jersey, Pennsylvania and other states.

The report of the secretary and treasurer showed the body to be in easy circumstances, both as to finance and representation. W. A. Drake, chairman of the Committee on Ethics, presented an excellent discussion on that subject, so good, indeed, that *Power* will soon print it at length.

Reports were received by numerous committees, that by A. G. Pratt of the Stoker Committee bringing out a discussion by W. H. Jacobi on distinguishing between boiler and stoker efficiency. Incidentally, much discussion is going on between British and American committees as to whether the gas or the wetted side of the heating surface should be used in computing its area. American practice is to use the fire side. British authorities acknowledge the technical correctness of this, but incline to the wetted side because in view of water walls, thin tubes and other extended surfaces. The wetted area is simpler of determination. A committee on boiler performance was asked to give the subject consideration.

S. Mensonides presented for Mr. Cassidy a report of the special committee appointed to attend the hearing before the Boiler Code Committee on dished heads, March 17.

The death of H. N. Corell, for several years secretary of the association, was announced, with suitable resolutions.

Better Marketing Here and Abroad

W. H. Rastall, Department of Commerce, gave an excellent address on "Possibilities of Boiler Export Business" and E. St. Elmo Lewis an address on "Marketing Your Products." He advocated a group organization to develop programs of education both inside and outside of the industry to develop sales power to find out what the market wants and what it needs; to educate the whole power-house group; to investigate foreign markets to develop and finance a five-year program to study legal developments.

The committee to confer with the Smoke Prevention Association told of progress in standardizing requirements for furnace details and further action found desirable with respect to two-pass self-contained boilers.

"We still hear much of the activities of central station power plants supplanting industrial power plants through the use of central station power," E. R. Fish said, in part:

"It is unquestionably true that many industrial plants can generate their own power cheaper than they can buy it. It is also unquestionably true that many industries are sold by the central station solicitor without looking with sufficient care into the conditions of their own plant and that if they did this they would not buy central station current.

"This is particularly likely to be true in those climates where heating is necessary through a considerable portion of the year and also in those industries where large quantities of steam are used for process purposes. It is undoubtedly true, however, that almost complete new equipment is required in most industrial power plants to make it possible to generate their own current and make steam economically, for power plant practice within the past few years has literally been revolutionized. Casual and spasmodic attempts have been made to spread this propaganda but no concerted effort has yet appeared. There are so many lines of apparatus interested that it would appear as if some effort might be made to bring together the manufacturers of all kinds of power plant equipment in order to concentrate in a centralized agency a mass of pertinent information that can be spread through a myriad of channels and thus gradually stop the tendency to discard the power plant and to bring back many of those that have changed over. This is essentially trade extension work and in line with some of the suggestions that have heretofore been made. The central stations are going to continue to grow and their field of usefulness will continue to extend. Any work that might be done in the way suggested above would not seriously interfere with central station progress nor would it interfere greatly with any of our relations with the central stations as purchasers of our equipment."

Water Tube Boiler Suspensions

H. E. Aldrich, reporting for the Committee on Water Tube Boiler Suspensions, gave the results of a canvass of the manufacturers of this type of boiler upon the results of which the following recommendations are based:

That the $\frac{L}{r}$ ratio be 120.

Maximum stress in cross-guides, 12,500 lb. per sq.in.

Maximum stress in hanger bolts, 8,000 lb. per sq.in.

It is recommended that a standard method be agreed upon as to what should be included in figuring the loads on supporting members. It is suggested that it should specifically include weight of bare boiler completely filled with cold water to which should be added the weight of all trimmings, fixtures, tile or brickwork carried on the boiler. It is suggested that it include only the material carried in the contract. If it is made to carry extra load of piping, etc., customer should assume the extra burden.

Prof. S. W. Parr gave an interesting talk on "Caustic Embrittlement,"

illustrated by lantern slides. The material is familiar to the readers of *Power* in Prof. Parr's recent papers and bulletins.

A special feature of the banquet was the singing of Miss Moore, daughter of the new vice-president.

The election resulted in the selection of Starr H. Barnum of the Bylow Co., New Haven as president and M. F. Moore, of the Kewanee Boiler Co., Kewanee, Ill., as vice-president. A. C. Baker, secretary-treasurer, is appointive.

S.H.V.E. States Many Papers for Summer Gathering

Results of investigations made during the last six months will be reported by various members and committees of the American Society of Heating and Ventilating Engineers at the 33rd semi-annual meeting which will be held at the Greenbrier Hotel, White Sulphur Springs, W. Va., June 28-30.

Sessions will be of interest for the engineer, the contractor or the architect who is actively interested in heating and ventilating engineering. The code for rating low-pressure heating boilers will be reported on by a committee headed by Alfred Kellogg, Boston, Mass.; the code for heating and ventilation of garages will be presented by O. N. Walther, Philadelphia, Pa., and the results of investigations of cast-iron radiator performances in various kinds of enclosures will be reported on by Prof. A. P. Kratz and M. K. Fahnestock as a result of investigations at the University of Illinois in recent months.

How an office-building heating plant was designed and its performance in daily service will be compared in a paper on "Heating and Ventilating of an Insulated Office Building," by F. M. Holbrook, Lancaster, Pa.; "Recent Developments in Direct-Connected Fans and Blowers" will be the topic of A. G. Sutcliffe, Chicago, Ill., while an outline of the "Development of Extended Surface Heating Units" will be presented by R. N. Trane, La Crosse, Wis. These topics and many others will be discussed during the sessions, which will be held from 9:30 a.m. until 1:30 p.m. each day.

Engineering Contracts Ahead of First Half of 1926

Construction keeps ahead of last year's records as the industry approaches the end of the first half. Figures for the entire United States show heavy engineering contracts for May, 1927, well in advance of those for the same month last year. The cumulative total, Jan. 1 to June 1, 1927, is also greater than for the corresponding period in 1926.

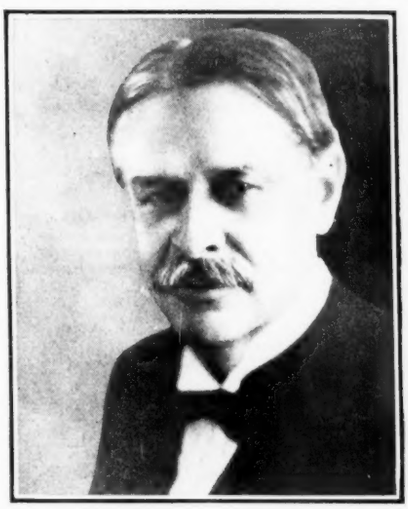
These gains are obviously not in buildings, but are confined to big oil and gas pipe lines, federal government projects, and public bridge jobs.

Wage rates of skilled construction trades mechanics continue to rise and strikes and wage controversies to multiply, regardless of reminders that the "building" boom has probably expended its force.

G. C. Ward Given Doctorate by S. California Univ.

George Clinton Ward, vice-president in charge of engineering and construction for the Southern California Edison Co. was presented by the University of Southern California with the honorary degree of Doctor of Engineering for his outstanding work in this field, at the commencement day exercises June 4.

Doctor Ward began his engineering career in New York State, following his graduation from Phillips Andover Academy. As chief engineer for the Raquett Lake Railway, he attracted the attention of Collis P. Huntington, and as a logical sequence became associated with the late Henry E. Huntington when the latter began his work in Southern California.



G. C. Ward

H. E. Huntington, looking about for an additional power supply for his electric railroad interests commissioned Doctor Ward to make a hydro-electric development in the High Sierra of Fresno County. This was the beginning of the Edison company's Big Creek-San Joaquin project. The most notable feature of this undertaking is the Florence Lake Tunnel, completed in 1925. This tunnel, thirteen miles in length, is the longest water tunnel of its bore in the world. It diverts the rainfall of the Florence Lake watershed into Huntington Lake, making it available for the four power houses of the Edison company now in service, as well as for others that are to be constructed.

Newcomen Society To Tour Plants in London Area

A varied program of inspection tours throughout the London area will comprise the summer meeting of the Newcomen Society scheduled for June 16 to 18 inclusive.

A visit to the Royal Mint, Messrs. Bryant & May's Match Works and Museum of Firemaking Appliances, the bookbinding and goldbeating establishments of Messrs. Robert Riviere & Son, 33 Heddon St., near 131 Regent St., W. 1, and Messrs. Geo. M. Whiley, 54 Whitfield St., Tottenham Court Road, W.1, a motor tour of the Metropolitan Water Board Stations, inspection of the Kew Bridge pumping station, Cornish engines by Boulton & Watt, 1808 and 1820, and those by Maudslay Sons & Field, 1836, and the "Bull" engine, are major features of the gathering.

Arizona Plans 200,000 Hp. Project on Colorado River

Power development covering a section of the Colorado River in the region of Parker, Ariz., is proposed in an application to the Federal Power Commission tendered by the board of directors of State Institutions in Arizona.

Plans embrace the building of a dam. to raise the river to a level of 90 ft. This will create a reservoir of 1,900,000 acre-ft. capacity. The power house is to be built on the Arizona side of the river, where an installation of 200,000 hp. will be made. Some 100,000 hp. of primary power will be developed.

The application is in conflict with previous applications by the Beckman & Linden Engineering Corp., San Francisco, Calif., the City of Los Angeles, and the Southern California Edison Co.

New Heating System for Ohio University

The Johns-Manville Co., in conjunction with the Esswein Heating & Plumbing Co., of Columbus, Ohio, has started to install the underground work for the heating system at the Capital University, Columbus.

Through the use of an improved type of installing underground steam lines it is possible to carry the steam without appreciable loss to a distance of 500 ft. The same system was used at Cornell University and has proved successful. The Woman's building, about 500 ft. away from the power plant, will be supplied by the central power plant.

Project on Warrior River

The Alabama Power Co., Attalla, Ala., plans to develop a project on the Warrior River, near Birmingham, Ala.

The project is to include a power plant at the government navigation dam No. 17, and a transmission line from the power plant to the applicant's transmission system near the boundary of the government land at Lock 17.

Primary capacity is estimated at 1,850 hp., the installed at 28,000.

Obituary

Charles R. Wood, president of R. D. Wood & Co., Philadelphia, Pa., internationally known engineer in the water works field, died suddenly June 8 from heart desease while attending a committee meeting of the annual convention of the American Water Works Association at the Hotel Sherman, Chicago, Ill. Mr. Wood was fifty-six.

Erity Fitch Herrick, chief engineer for the National Chemical Co., died at Youngstown, Ohio, on May 8. He served his apprenticeship with the Union Works of Buffalo. Sometime later he was graduated from Pratt

Institute, New York City. He then served a three years' apprenticeship course at the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. The works of the National General Chemical Co. employed him as its chief engineer and it was this position he held at the time of his death. He held positions with the Standard Steel Castings Co. as master mechanic for three years and previous to that time was connected with the Travelers Insurance Co. of Cleveland, and the Babcock & Wilcox Co., Barberton, Ohio. Mr. Herrick was a member of the Electrical Maintenance Engineers of Cleveland a member of the National Safety Council and a member of this Society since 1926.

Personal Mention

S. H. Blake will succeed A. H. Moore as chairman of general and other standardizing committees of the General Electric Co.

Jiles W. Haney has been appointed chairman of the mechanical engineering department of the University of Nebraska, Lincoln, Neb.

A. H. Moore, electrical engineer for 39 years with the General Electric Co. and its associated foreign manufacturing companies, will retire Aug. 1, 1927, on account of ill health.

Prof. A. G. Christie, accompanied by his family, sailed on June 10 for England. Professor Christie will spend three or four months in consulting work of a confidential advisory nature.

Alfred O. Blackman, formerly superintendent of power for the Yale & Towne Manufacturing Co., Stamford, Conn., is now consulting engineer, with offices in New York City.

C. E. Davies, assistant secretary of the A.S.M.E. and managing editor of Mechanical Engineering, will sail on June 25 for a prolonged pleasure trip in Europe.

F. H. Daniels, president of the Riley Stoker Corp., with Mrs. Daniels, sailed on May 26, for a combined business and pleasure trip through England, France and Germany, to return in mid-July.

C. R. Bell, formerly assistant mechanical engineer for the Ridgway Dynamo & Engine Co., Ridgway, Pa., is now secretary-treasurer for the Minute Chemical Patch Co., Cleveland, Ohio.

Dr. W. F. G. Swann, who for the last two years has been head of the department of physics at Yale University and director of the Sloane Laboratory there, will become in September director of the Franklin Institute Laboratories.

Dr. Edward Dean Adams, John Fritz Medalist, honorary member and former vice-chairman of the Engineering Foundation Board, has accepted the mission of delegate to the celebration of the 500th anniversary of the founding of Louvain University. He will attend the ceremonies.

Coming Conventions

American Association of Engineers. Annual convention, Tulsa, Okla., June 6-8; M. E. McIver, 63 East Adams St., Chicago.

American Institute of Electrical Engineers. F. L. Hutchinson, secretary, 33 West 39th St., New York City. Summer convention at Detroit, Mich., June 20-24 inclusive; Pacific Coast convention at Del Monte, Calif., Sept. 13-16.

American Order of Steam Engineers. Annual convention, Moose Hall, 1314 North Broad St., Philadelphia, Pa., June 13-16; J. E. Burke, 1821 So. Ringgold St., Philadelphia.

American Society of Civil Engineers. George T. Seabury, secretary, 33 West 39th St., New York City. Annual convention at Denver, Col., July 13-15.

American Society of Mechanical Engineers. Calvin W. Rice, secretary, 33 West 39th St., New York City. Seattle, Wash. Section, Aug. 29-31.

American Society for Testing Materials. Annual convention at French Lick Springs Hotel, French Lick, Ind., June 20-24; J. K. Rittenhouse, secretary, 1315 Spruce St., Philadelphia, Pa.

American Water Works Association. W. M. Niesley, assistant secretary, 170 Broadway, N. Y. Annual convention Hotel Sherman, Chicago, June 6-11.

Association of Iron and Steel Electrical Engineers. Annual convention at Pittsburgh, Pa., June 13-18, inclusive.

National Association of Practical Refrigerating Engineers. Eighteenth annual convention and educational exhibition in Civic Convention Hall and headquarters Hotel Whitcomb, San Francisco, Calif., Nov. 29 to Dec. 2. H. Fox, 5707 W. Lake St., Chicago, Ill.

National Association of Stationary Engineers—Annual convention at Ambassador Hotel, Los Angeles, Calif., Aug. 22-27; John Topman, secretary, convention committee, Ohio State annual convention in Memorial Hall, Lima, Ohio, June 16-18; P. H. Grigsby, secretary, Lima, Ohio. New England States convention at Portland, Me., June 17-18; Thomas H. Clark, president, Worcester, Mass.; Robert Johnson, secretary, 65 Charlotte St., Worcester, Mass., Hartford meeting June 24-25, business sessions Saturday morning, aviation flight and banquet. Illinois and Iowa conventions at Rock Island, Ill., June 22-24; secretary, William Hamilton, 719 Main St., Decatur, Ill. Wisconsin convention at Racine, July 19-22, secretary R. L. Scott, 410 Congress St., Eau Claire, Wis.

National Board of Boiler and Pressure Vessel Inspectors. Annual meeting at Nashville, Tenn., June 14-16 inclusive.

Universal Craftsmen Council of Engineers. Thomas H. Jones, secretary, 33 Linden Ave., Cherrydale, Va. Annual convention at Buffalo, N. Y. Aug. 2-6.

Charles T. Drake, treasurer of The New York Section of The American Society of Refrigerating Engineers, died suddenly Sunday, June 5 at his home 8826 183d St., Hollis, Long Island, N. Y. As a tribute to Mr. Drake, President Bennis has decided to cancel the proposed meeting of the New York Section for the month of June.

Society Affairs

New England Water Works Association, in conjunction with the Boston Society of Civil Engineers will enjoy its annual outing at Amesbery and Haverhill, Mass., June 21.

Providence Engineering Society will hold an outing and clambake at Chapmist Inn, Providence, R. I., June 21.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	June 6 1927
Pool 1	New York	$2.50@$2.75
Smokeless	Boston	1.77
Clearfield	Boston	1.65@ 1.80
Somerset	Boston	1.75@ 2.00
Kanawha	Columbus	1.35@ 1.50
Hocking	Columbus	1.75@ 1.90
Pittsburgh	Pittsburgh	2.00@ 2.10
Pittsburgh gas slack	Pittsburgh	1.45@ 1.60
Franklin, Ill.	Chicago	
Central, Ill.	Chicago	
Ind. 4th Vein	Chicago	
West Ky.	Louisville	1.40@ 1.60
S. E. Ky.	Louisville	1.40@ 1.75
Big Seam	Birmingham	1.50@ 1.90
Anthracite Gross Tons		
Buckwheat No. 1.	New York	2.35@ 3.00
Buckwheat No. 1.	Philadelphia	2.50@ 3.00
Birdseye	New York	1.40@ 1.60

FUEL OIL

New York—June 9, light oil, tank-car lots; 28@34 deg. Baumé, 5¼c. per gal.; 36@40 deg., 5½c. per gal. f.o.b. Bayonne, N. J.

St. Louis—May 25, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.70 per bbl.; 26@28 deg., $1.75 per bbl.; 28@30 deg., $1.80 per bbl.; 30@32 deg., $1.85 per bbl.; 32@36 deg., gas oil, 4.12c. per gal.; 38@40 deg., 5.24c. per gal.

Pittsburgh—June 1, f.o.b. local refinery; 30@34 deg., fuel oil, 6c. per gal.; 36@40 deg., fuel oil, 6¼c. per gal.

Philadelphia—June 2, 27@30 deg., $2.20½@$2.26½ per bbl.; 13@19 deg., $1.75@$1.81 per bbl.

Cincinnati—June 6, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 6½c. per gal.; 26@30 deg., 6⅝c. per gal.; 30@32 deg., 7c. per gal.

Chicago—May 21, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., 97½c. per bbl.; 26@30 deg., $1.05; 30@32 deg., $1.12½.

Boston—June 6, tank-car lots, f.o.b. 12@14 deg. Baumé, 4¼c. per gal.; 28@32 deg., 5.8c. per gal.

Dallas—May 27, f.o.b. local refinery, 26@30 deg., $1.40 per bbl.

Business Notes

The Falk Corp., Milwaukee, Wis., manufacturers of Herringbone gears, speed reducers, steel castings, Diesel engines and flexible couplings, have opened an office in Chicago at 122 South Michigan Ave. The office will be in charge of C. H. Thomas.

The Chain Belt Company, Milwaukee, Wis., manufacturers of Rex chains, transmission, elevating and conveying machinery, have a Seattle office now at 1212 Sixth Avenue South, Seattle, Wash. The Stearns Conveyor Co., Cleveland, Ohio, manufacturer of Stearns idlers. was recently purchased by this company.

J. S. Schofield's Sons Co., Macon, Ga., with branch offices at Atlanta, Ga., and Tampa, Fla., has passed three-quarters of a century in the manufacture of industrial machinery and power equipment. From a one-man enterprise founded by John Shepley Schofield in 1852, the J. S. Schoefield's Sons Co. has grown to a large organization serving industries in many sections of the country and abroad.

Trade Catalogs

Power Plant Equipment—Engberg's Electric & Mechanical Works, 271 Vine St., St. Joseph, Mich., manufacturing vertical, enclosed self-oiling steam engines and generating sets, has issued an illustrated bulletin on power-plant equipment installed by the company.

Separators Used as Steam Purifiers—The Cochrane Corp., Philadelphia, in Bulletin No. 674, describes separators used as steam purifiers. Tests on separators installed on a Stirling boiler fed with water containing 20 grains per gal. of total solids and operated between 200 and 300 per cent of rating, are described and show that the steam issuing from the separator contained less than ½ per cent of moisture.

Apron Conveyors—The Jeffrey Manufacturing Co., Columbus, Ohio, manufacturer of chains, conveying and crushing machinery, has issued Catalog No. 435 featuring Jeffrey standard apron conveyors. The wide range of application of Jeffrey wood and steel apron conveyors in handling both bulk and package materials in many industries is described, shown by illustrations. Typical layouts giving general dimensions accompany the tables of specifications.

Steel Mixture Veneer Walls—The McLeod & Henry Co., 31 Monroe St., Troy, N. Y. A different type of furnace lining is interestingly illustrated and described in a new catalog, No. 161, on steel mixture veneer walls. The company is willing to send a copy to any interested reader.

Electrically Operated Fluid Meters—The Bailey Meter Co., Cleveland, Ohio, has issued a 24-page bulletin, No. 131, descriptive of a new line of electrically operated fluid meters which may be used to indicate, record and integrate the flow of steam, water, air, gas and other fluids. Due to the electrical principle of operation the indicating, recording and integrating instruments can be arranged in any combination, or located at any distance from the pipe line in which the flow is being measured. The bulletin contains a number of illustrations showing applications of these meters for measuring the steam consumption of machines, and processes.

New Plant Construction

Ark., Batesville—Arkansas Power & Light Co., Pine Bluff, plans extensions and improvements to power and light plant including transformer station, transmission lines, etc. here. Estimated cost $750,000. Private plans.

Ark., Hot Springs—E. G. Mattar, is having preliminary plans prepared for a 15 story hotel including steam heating system, etc. Estimated cost $750,000. F. W. Gibbs & Co., Gazette Bldg., Little Rock, are architects.

Ark., Pine Bluff—Harding Lake Drainage Dist., R. H. Williams, Chn., is having preliminary plans prepared for the construction of drainage ditches, flood control system, etc. including pumping equipment. Estimated cost $320,000. E. Hale, G. B. Smith and E. B. Reynolds, are engineers.

Calif., Los Angeles—B. F. Goodrich Rubber Co., Akron, O., is having plans prepared for the construction of a plant including power house, engine rooms, etc. on Mines Ave. here. Estimated cost $4,000,000. S. B. Robertson, c/o owner, is engineer.

Calif., Los Angeles—Missionary Sisters of the Sacred Heart, is having plans prepared for the construction of an 8 story hospital including steam heating system, elevators, etc., at Sunset Blvd. and Hill St. Estimated cost $800,000. R. Meier, 402 Title Insurance Bldg., is architect.

Calif., Los Angeles—J. Steinberg, 134 South Van Nuys St., awarded contract for the construction of a 12 story loft building at Los Angeles and Seventh Sts., to W. Douglas Lee, 704 Textile Center Bldg. Estimated cost $750,000. Electric elevators will be installed.

Del., Newark — Town Council, E. B. Frazer, Pres., will receive bids until June 22 for waterworks improvements including well, sewage pumping station, etc.

Fla., Haines City — City, J. P. Ferrill, Mgr., will receive bids until June 29 for the construction of a sewage disposal plant and pumping station. Weideman & Singleton, 1404 Candler Bldg., Atlanta, Ga., are consulting engineers.

Fla., Jacksonville—City Commission, F. H. Owen, Chn., will receive bids until June 27, for extensions and improvements to electric light plant. Scofield Engineering Co., Commercial Trust Bldg., Philadelphia, Pa., is engineer.

Ill., Chicago—W. C. Bannerman & Co., 77 West Washington St., is having plans prepared for the construction of a 13 story apartment at 7321 South Shore Dr. Estimated cost $1,000,000. Robert S. DeGoyler & Co., 307 North Michigan Ave., are architects.

Ill., Chicago—A. S. Alschuler, 28 East Jackson Blvd., Archt., will soon receive bids for the construction of a 12 story printing building including elevators, etc. at 714-728 West Van Buren St. for A. O'Rourke, 111 West Washington St. Estimated cost $2,000,000.

Ill., Riverside—Chicago Zoological Society, c/o E. H. Clark, 8 East Huron St., Chicago, Archt., will soon award contract for the construction of a group of buildings including power house, etc. here.

Ill., Waukegan—B. K. Gibson, 624 South Michigan Ave., Archt., will soon receive bids for the construction of a 9 story hotel at Washington and Utica Sts. for Hotel Realty Building Co., operated by Hi-way Hotel Co. Estimated cost $500,000. Elevators, etc. will be installed.

Ind., Indianapolis—Riley Memorial Hospital Assn., West Michigan St., awarded contract for the construction of a hospital to Leslie Colvin, 823 Continental Bank Bldg. Estimated cost $500,000.

Ind., Terre Haute—Fairbanks Heirs, awarded contract for the construction of a 10 story hotel to W. P. Jungclaus, 825 Massachusetts Ave., Indianapolis. Estimated cost $1,000,000.

Ia., Cedar Rapids — Orpheum Theatre Corp., 422 West 4th St., Waterloo, awarded contract for the construction of an office and stores building to R. Levine & Co., 6951 South Green St., Chicago, Ill. Estimated cost $1,000,000.

Ia., Le Mars—F. O. Kehrberg, Sheldon, and W. Steiner, Sibley, are having preliminary plans prepared for the construction of a heating plant here. Estimated cost $125,000.

Kan., Abilene—City plans the construction of a sewage pumping plant, etc. Estimated cost $35,000. Burns & McDonnell Engineering Co., 401 Interstate Bldg., Kansas City, Mo., engineer.

La., Monroe—Monroe Ice Co., awarded contract for the construction of an ice plant at Lovers Lane to M. O'Brien. Estimated cost $100,000.

Md., Baltimore—Hecht Bros., Baltimore and Pine Sts., awarded contract for the construction of addition to department store to Consolidated Engineering Co., 20 East Franklin St. Estimated cost $500,000.

Mass., Northboro — Northboro Electric Co., 250 Main St., awarded contract for the construction of a transformer station on Hudson St. to Westinghouse Electric & Mfg. Co., 30th and Walnut Sts., Pittsburgh, Pa. Estimated cost $40,000.

Mass., Worcester—Boston & Albany R.R., South Station, Boston, is receiving bids for the construction of a boiler house and compressor room, here. G. A. Kirley, is chief engineer.

Mich., Detroit—Grand Trunk R.R. Terminal & Cold Storage Co., c/o Moores & Dunford Inc., 110 East 42nd St., New York, N. Y., Archts. and Engrs., awarded contract for the construction of a cold storage warehouse here, to Bryant & Detweiler, 2336 Dime Bank Bldg., Detroit, Mich. Estimated cost $2,000,000.

Minn., Minneapolis—Sears, Roebuck & Co., C. M. Kittle, Pres., Arthington and Homan Sts., Chicago, Ill., awarded contract for the construction of a 12 story mail order plant at Lake and 29th Sts. and Elliot and 10th Aves. here, to J. H. Beuttas of B.-W. Construction Co., 720 Cass Ave. Estimated cost $2,000,000 to $3,000,000.

Steam heating system, etc. will be installed.

Miss., Mendenhall—Gulf & Ship Island R.R., c/o Illinois Central System, 135 East 11th Pl., Chicago, Ill., awarded contract for the construction of a sand dryer and compressor house, etc. here, to Zitterell Mills Co., Webster City, Ia.

Miss., Water Valley—City is having preliminary plans prepared for the construction of a waterworks system and electric light plant. T. H. Allen, 840 Bank of Commerce Bldg., Memphis, Tenn.

Mo., Kansas City—McCanles Building Co., 400 Victor Bldg., will build two 10 story hotel buildings at 3829-3835 Main St. by day labor. Private plans.

Mo., St. Louis—Bd. of Public Service, awarded contract for the construction of

a municipal service building including central heating plant, etc. at 12th St. and Clark Ave. to McCormick-Combs Construction Co., 318 North 8th St. Estimated cost $825,000.

Mo., St. Louis—Missouri Pacific R.R., Railway Exchange Bldg., awarded contract for the construction of a 22 story office building including boiler house, etc. at 13th, Olive and Pine Sts. to Humes-Deal Construction Co., Syndicate Trust Bldg. Estimated cost $2,000,000.

Mo., St. Louis—National Candy Co., 208 North Broadway, is having plans prepared for the construction of a factory including refrigeration plant, etc. at Grovois and Bingham Sts. Esitmated cost $1,000,000. Klipstein & Rathmann, 316 North Eighth St., are architects.

Mo., St. Louis—Superior Enamel Products Co., 1542 North Tenth St., awarded contract for the construction of a factory for the manufacture of enamel products. Estimated cost $250,000. Electrically heated enameling furnaces and complete system of conveyors, etc. will be installed.

N. J., East Orange—Komb Construction Co., c/o E. V. Warren, 31 Clinton St., Newark, Archt., had revised plans prepared for the construction of a 7 story apartment including steam heating and refrigeration systems, boilers, elevators, etc. at 91 Washington St. here. Estimated cost $500,000.

N. J., Glen Ridge—G. Gabrielson & A. Olsen, 364 Main St., East Orange, are having sketches made for the construction of a 4, 5 or 6 story apartment including steam heating and refrigeration systems, boilers, etc. on Bloomfield Ave. here. Estimated cost $700,000. Private plans.

N. J., Jersey City—Plaza Apartment Hotel Corp., 3010 Hudson Blvd., will build a 7 story addition to hotel including steam heating and refrigeration systems, boilers, elevators, etc. on Sip Ave. Estimated cost $500,000. Clinton & Russell, 100 Maiden Lane, New York, N. Y., are architects. Work will be done by separate contracts.

N. J., Jersey City—Public Service Electric & Gas Co., 80 Park Pl., Newark, awarded contract for the construction of a switching station here to Public Service Production Co., 80 Park Pl., Newark. Estimated cost $100,000.

N. J., Newark — Public Service Corp., Terminal Bldg., is having plans prepared for the construction of a 15 story office building on East Park and Pine St. Estimated cost $500,000. Public Service Production Co., Park Pl., is architect.

N. Y., Pelham Manor—Pelham-Biltmore Corp., Huguenot Trust Bldg., New Rochelle, awarded contract for the construction of a 4, 6 or 7 story apartment at Boston Post Rd. to J. R. Altiere Co., Wolf Lane. Estimated cost $2,000,000. Steam heating and ventilation systems, boilers, pumps, elevators, swimming pool, etc. will be installed.

O., Canton—City awarded contract for the construction of a hospital including boiler house, etc. on Alliance Rd. to Melbourne Construction Co., Cleveland Ave. N.W. Estimated cost $700,000.

O., Peebles—City is having plans prepared waterworks improvements including reservoir, pumping plant, mains, etc. Estimated cost $60,000. Jennings-Lawrence Co., Hartman Bldg., Columbus, is engineer.

Pa., Philadelphia — Bellevue - Stratford Hotel, Broad and Walnut Sts., awarded contract for the construction of a hotel to Wark Co., 1600 Walnut St. Estimated cost $1,000,000. Refrigeration system, electric elevators, etc., will be installed.

Pa., Philadelphia—Charles J. McIlvaine, c/o M. Ilvaine & Roberts, 112 South 16th St., Archts., plans the construction of a 20 story apartment at 2027-2035 Locust St. Estimated cost $1,000,000.

Pa., Philadelphia—Owner, c/o Ritter & Shay, Packard Bldg., Archts., are having plans prepared for the construction of a 25 story hotel at Broad and Spruce Sts. Estimated cost $4,000,000.

Pa., Pittsburgh—Rodgers Sand Co., 1 Wood St., awarded contract for the construction of a sand and gravel plant including boiler house, etc. on Ridge Ave. to W. F. Trimble & Sons, 1719 Pennsylvania Ave. Estimated cost $250,000.

Pa., Upper Darby (Philadelphia P. O.)—W. Freihofer, 20th and Indiana Aves., Philadelphia, awarded contract for the construction of a theatre and stores building at 69th and Ashbridge Sts. here, to G. Kessler Contracting Co., 1733 Marvine St., Philadelphia. Estimated cost $850,000.

Tex., Big Spring—Winn Produce Co. is having plans prepared for the construction of a cold storage plant. Estimated cost $40,000. Private plans.

Tex., Del Rio—Texas Central Power Co., Frost Bldg., San Antonio, is having plans prepared for the construction of a hydroelectric plant and dam on the Devils River near here, also power transmission lines in upper border region of Texas to intersect with company's extensive system near San Antonio. Estimated cost $2,000,000. Private plans. Machinery and equipment will be required.

Tex., Henderson—City awarded contract for the construction of an electric light plant to Fairbanks-Morse & Co., 900 South Wabash Ave., Chicago, Ill. Estimated cost $80,000.

Tex., Wichita Falls—City plans waterworks improvements including pumping plant, 12,000,000 gal. water purification plant, 2,500,000 gal. reservoir, etc. Estimated cost $1,750,000. Black & Veatch, Mutual Bldg., Kansas City, Mo., are engineers.

Wash., Seattle—Exeter Co., 517 Skinner Bldg., will receive bids about June 16 for the construction of a 14 story hotel at Eighth Ave. and Seneca St. Estimated cost $1,000,000. Stuart & Wheatley, Walker Bldg., are architects.

Wash., Seattle—Marlborough Investment Co., c/o E. W. Morrison, Seaboard Bldg., Archts., awarded contract for the construction of a 12 story apartment at Boren Ave. and University St. to Western Construction Co., Seaboard Bldg. Estimated cost $800,000. Two electric elevators will be installed.

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Equipment Wanted

Air Compressor—N. M. Longbothum, R. F. D. No. 2, Northport, N. Y., wants prices and catalogs on an automatic motor driven air compressor, 110 v., 60 cycle, for mounting on a 5 yd. Marion steam shovel.

Boilers—J. A. Wetmore, Acting Supervising Architect, Treasury Dept., Washington, D. C., will receive bids for boilers at various post offices, June 20, Victoria, Tex., June 21, Albert Lea, Minn., June 22, Jackson, Mich., June 23, Columbus, Ga. and June 27, Baker City, Ore.

Engine—City Commission, Bordentown, N. J., plans the installation of a Diesel oil engine for waterworks. Estimated cost $15,000.

Engine — Scotland Supply Co., Johns, N. C., is in the market for a 75 to 100 hp. oil engine to operate cotton gin.

Generator Set—C. A. Hoppin & Co., 203 Madison Theatre Bldg., Peoria, Ill., is in the market for a 300 kva. high speed engine generator set, 3 ph., 60 cycle, 220 v.

Heating System—Bureau of Yards & Docks, Navy Dept., Washington, D. C., will receive bids until June 22 for the installation of a heating system at Naval Operating Base, San Diego, Calif.

Heating System, Boilers, etc.—Superintendent of Purchase, Division of Standards and Purchases, Executive Dept., Capitol, Albany, N. Y., will receive bids until June 23 for the installation of a heating system, boilers, etc. in New York State Woman's Relief Corps Home, Oxford, N. Y.

Insulators — Dept. of Public Works, Wellington, N. Z., will receive bids until July 7 for high tension transmission line suspension insulators for Waikaremoana electric power scheme.

Pumping Equipment—City of Cresbyton, Tex., will be in the market for pumping equipment, etc., for proposed waterworks improvements. Estimated cost $25,000.

Pumping Equipment, Etc.—City of Kosciusko, Miss., will receive bids until June 21 for pumping equipment, etc. for proposed sewage pumping plant. Estimated cost $90,000.

Pumping Equipment, etc. — City of Crystal City, Tex., will receive bids until June 22 for pumping equipment for proposed waterworks improvements. Estimated cost $20,000.

Pumps, Etc.—City of Merkel, Tex., will readvertise for bids later for one 300 or 175 g.p.m. deep well pump and one 500 g.p.m. high service motor driven centrifugal pump, etc. for proposed waterworks improvements. Former bids rejected.

Pumps—Water Commission, L. L. Knox, Secy., Goderich, Ont., wants prices and catalogs on gasoline driven pumps for proposed auxiliary waterworks system.

Pumps and Motors—City of Seminole, Okla., is in the market for three 60 g.p.m. deep well pumps and 7 hp. motors for proposed waterworks improvements. Estimated cost $65,000.

Pumps and Motors—City of Wanette, Okla., will be in the market for two deep well pumps and motors for proposed waterworks improvements. Estimated cost $40,000.

Pumps, Switchboard, etc. — E. Cooper, Clk., Bloomington, Ind., will receive bids until July 7 for gasoline and electric motor driven centrifugal pumps, vacuum and sump pumps, switchboard apparatus, etc., for proposed waterworks improvements.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

PRICE fluctuations of the last four weeks were few in number and most of the changes that did occur represented movements in an upward direction. Boiler and other rivets are higher at mills, while highest grade babbitt metal advanced 1c. per lb. during the month. Certain of the paint materials appear firmer.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket	(net) 68c. per ft.	
Common, 2½-in., cotton-rubber lined	80c. per ft. list less	50%

Air—Best grade

	3-ply	4 ply
¾-in., per ft.	$0.34	$0.42

Steam—Discounts from List

First grade	40%	Second grade	40–5%	Third grade	50%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade 50% Second grade 50–10%

LEATHER BELTING—List price, 24c. per lin.ft. per inch of width for single ply at New York warehouses.

Grade	Discount from list
Medium	40–5%
Heavy	30–10%

RAWHIDE LACING—For cut, best grade, 50%, 2nd grade, 60%. For laces in sides, best, 41c. per sq.ft.; 2nd, 37c. Semi-tanned: cut, 50%; sides, 41c. per sq.ft.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ¼ in.	$0.95
Asbestos for high-pressure steam, ½ in.	1.75
Duck and rubber for piston packing	.95
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.85
Wire insertion asbestos sheet	1.30
Rubber sheet	.50
Rubber sheet, wire insertion	.80
Rubber sheet, duck insertion	.60
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia high pressure		50%
Asbestos, air cell, for low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.35@$2.50 per bbl. without bags, in carload lots delivered on job. Bag charge of 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 16-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier; all $3.34 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York	Cleveland	Chicago
White	10.00@13.50	16.00	15.00@20.00
Colored	9.00@13.00	12.00	12.00@17.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed, white wipers, as follows:

Chicago	$0.15
New York	.15½
Cleveland (*per thousand*)	36.00

LINSEED OIL—These prices are per gallon:

	New York	Cleveland	Chicago
Raw in barrels (5 bbl. lots)	$0.89½	$0.99	$0.90

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry		In Oil	
	Current	1 Yr. Ago	Current	1 Yr. Ago
Red	$15.25	$15.25	$16.75	$16.75
White	15.25	15.25	15.25	15.25

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

Tank rivets, ⅞-in., dia. and smaller, list (Apr. 1, 1927) less 50-10%. EXTRA per 100 lb. for ½-in. dia., 35c.; ⅝-in., 15c.; 1-in., 5c.; lengths, 1-in. and shorter, 25c.; longer than 1-in. up to and including 1½-in., 15c.; longer than 5-in., 25c.; standard countersunk head, 25c.

Structural rivets, per 100 lb.:
New York $5.00* Chicago $3.50 Pittsburgh mill $2.75

Cone-head boiler rivets, per 100 lb.:
New York $5.00* Chicago $3.70 Pittsburgh mill $3.15

*Full kegs.

REFRACTORIES—Prices in car lots f.o.b. plant:

Chrome brick, eastern shipping points	net ton	$45.00
Chrome cement, 40@50% Cr_2O_3, in bulk	net ton	22@25
Chrome cement, 40@50% Cr_2O_3, in sacks	net ton	26@29
Magnesite brick: 9-in. straights	net ton	65.00
Magnesite brick: 9-in. arches, wedges and keys	net ton	71.50
Magnesite brick: Soaps and spits	per ton	91.00
Silica brick: Mt. Union, Pa.	per M	43.00
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	43@46
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	35@38
Clay brick, 2nd quality 9 in. shapes, Maryland	per M	35@38
Chrome ore crude, 40@50%	net ton	18.00@22.50

BABBITT METAL—Delivered, New York, cents per lb.:

Genuine, highest grade	86.00
Commercial genuine, intermediate grade	61.00
Anti-friction metal, general service	31.50
No. 4 babbitt (f.o.b.)	13.00

COLD DRAWN STEEL—Warehouse prices are as follows:

	New York	Cleveland	Chicago
Round shafting and screw stock, per 100 lb. base	$4.00	$3.90	$3.60
Flats and squares, per 100 lb. base	4.50	4.40	4.10

BOILER FITTINGS—F. o. b. New York or Jersey City, discounts on list:

	Current
Copper ferrules	70%
Boiler flanges	65-5%
Boiler stay bolts	60%
Boiler patch bolts	10%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following percentage discounts are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1½	30	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 and 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	7
11 and 12	44	31½			

BOILER TUBES—Following are net prices per 100 ft. in New York warehouse of tubes manufactured according to specifications of the American Society of Mechanical Engineers.

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$17.07
1¼	.....	.....	19.20
1½	.....	$38.00	17.92
1¾	.....	28.50	20.48
2	$17.33	25.00	20.24
2¼	19.84	28.25	23.00
2½	21.60	34.00	26.03
3	25.50	42.50	27.04
3¼	30.25	49.50	30.67
3½	31.50	52.75	33.33
4	38.03	67.00	40.11

Tubes 2¼ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.

These prices are net per 100 ft. based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

2 in. and smaller, 5c. per cut. 3 in., 9c. per cut
2½ and 2¾ in., 6c. per cut. 3¼ to 4 in., 10c. per cut

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$30.00 (net)	$50.00 (net)	$180.00	$220.00
No. 12 solid	136.00	180.00	225.00	275.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	305.00	375.00	420.00	500.00
No. 6 stranded	440.00	530.00	615.00	.....

From the above lists discounts are:	Lead Covered
Less than coil lots	20%
Coils to 1,000 ft.	30%
1,000 to 5,000 ft.	35%
5,000 ft. and over	38%

CONDUIT, Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, Per 100 pieces, f.o.b. New York, with 10-day discount of 5 per cent.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
¼	$56.50	$61.34	$7.76	$8.83	$4.52	$4.92
¾	72.07	78.63	10.21	11.63	6.46	7.03
1	103.31	113.00	15.10	17.21	8.39	9.13
1¼	139.77	152.88	20.51	23.07	11.78	12.75
1½	167.12	182.79	27.34	30.76	14.56	15.75
2	224.85	245.94	50.13	56.40	19.41	21.01
2½	355.50	388.85	82.03	92.28	27.73	30.01
3	464.88	508.50	218.74	246.10	41.59	45.01
3½	585.30	637.74	483.04	543.46	55.46	60.02
4	714.17	776.30	558.23	628.06	69.32	75.02

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG, SOLID NEUTRAL OR 2 FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	35
T. P. M. L.	.27	T. P. D. B.	47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID NEUTRAL OR 2 FUSE

	0-30 Amp.	31-60 Amp	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$17.75
No. 16 cotton reinforced heavy		22.00
No. 18 cotton reinforced light		14.50
No. 16 cotton reinforced light		18.35
No. 18 cotton Canvasite cord		14.75
No. 16 cotton Canvasite cord		17.20
No. 16 super service cord or similar (2 wire) in 1,000 ft.	$82.00	*90.50
No. 14 super service cord or similar (2 wire) in 1,000 ft.	121.00	*133.10

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.15	3-amp. to 30-amp.	100	$0.30
35-amp. to 60-amp.	100	.30	35-amp. to 60-amp.	100	.60
61-amp. to 100 amp.	50	.90	65-amp. to 100-amp.	50	1.50
101-amp. to 200-amp.	25	2.00	110-amp. to 200-amp.	25	2.50
201-amp. to 400-amp.	25	3.60	225-amp. to 400-amp.	25	5.50
401-amp. to 600-amp.	10	5.50	450-amp. to 600-amp.	10	8.00

Discount: Less 1-5th standard package, 60%; 1-5th to standard package, 64%; standard package, 68%

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30-amp.	$0.03 ea.	$0.05	100	100
35 to 60-amp.	.05 ea.	.06	100	100
65 to 100-amp.	.10 ea.	.10	50	50
110 to 200-amp.	.15 ea.	.15	25	50
225 to 400-amp.	.30 ea.	.30	25	25
450 to 600-amp	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken carton	5%
Unbroken carton but less than std. pkg.	22%
Std. pkg.	40%
Discount Without Contract—Renewals:	
Less than std. pkg.	Net list
Standard package	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons but less than standard package	26%
Standard package	42%
Discount With Contract—Renewals:	
Less standard package	Net list
Standard package	42%

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package (500)	$2.75
0-30 ampere, less than standard package	3.00

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard A type bulbs:

100—130 Volt Watts	Type	Price Each
15	A 17	$0.23
General		
25	A 19	.23
40	A 21	.23
50	A 21	.25
60	A 21	.25
100	A 23	.40

200—260 Volt Watts	Type	Price Each
Special		
25	A 19	$0.28
50	A 21	.28
100	A 23	.50

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0.18
Composition 2-piece attachment plug	.27
Swivel attachment plug	.12
Small size—2 Pc. Plug—Composition	.07

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$6.00	$9.00	$10.80	$17.05
12	9.70	12.20	14.20	23.20
10	12.80	15.70	18.10	30.15
8	18.70	21.40	23.70	41.75
6	.....	.....	33.75	.....
4	.....	.....	47.00	.....
2	.....	.....	66.25	.....
1	.....	.....	91.00	.....
0	.....	.....	112.50	.....
00	.....	.....	133.00	.....
000	.....	.....	159.40	.....
0000	.....	.....	190.24	.....

SOCKETS, BRASS SHELL—Price each, net:

	½ In. or Pendant Cap Key	½ In. or Pendant Cap Keyless	½ In. or Pendant Cap Pull	¾ In. Cap Key	¾ In. Cap Keyless	¾ In. Cap Pull
Standard package	$0.17	$0.15	$0.22	$0.20	$0.18	$0.25
Unbroken carton	.18	.16	.23	.22	.19	.26
Broken carton	.20	.18	.25	.24	.21	.28

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 33c. lb.; 100 lb. lots	31c lb.
Rubber tape, ¾ in., less 100 lb. 35c. lb.; 100 lb. lots	33c lb.
Wire solder, less 100 lb. 33c. lb., 100 lb. lots	31c. lb.
Soldering paste, 2 oz. cans	$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c. or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:	
Less than $25.00 list value	30%
$25.00 to $50.00 list value	30–5%
$50.00 list value or over	35%